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(54) **CURRENCY HANDLING SYSTEM HAVING MULTIPLE OUTPUT RECEPTACLES**

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See application file for complete search history.

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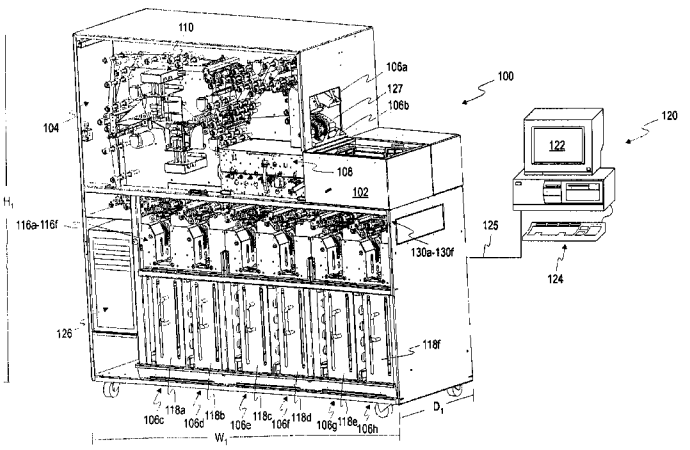
(57) **ABSTRACT**

A method and apparatus for handling bill jams within a currency processing device is provided. The device includes a transport mechanism adapted to transport bills along a transport path, one at a time, from the input receptacle past an evaluation unit into a plurality of output receptacles. At least one of the output receptacles includes a holding area and a storage area. A plurality of bill passage sensors are sequentially disposed along the transport path that are adapted to detect the passage of a bill as each bill is transported past each sensor. An encoder is adapted to produce an encoder count for each incremental movement of the transport mechanism. A controller counts the total number of bills transported into each of the holding areas and the total number of bills moved from a holding area to a corresponding storage area after a predetermined number of bills have been transported into the holding area. The controller tracks the movement of each of the bills along the transport path into each of the holding areas with the plurality of bill passage sensors. The presence of a bill jam is detected when a bill is not transported past one of the plurality of bill passage sensors within a requisite number of encoder counts. The operation of the transport mechanism is suspended upon detection of a bill jam. The bills from each of the holding areas are moved to the corresponding storage areas upon suspension of the operation of the transport mechanism. Remaining bills are then flushed from the transport path after moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism.

45 Claims, 24 Drawing Sheets



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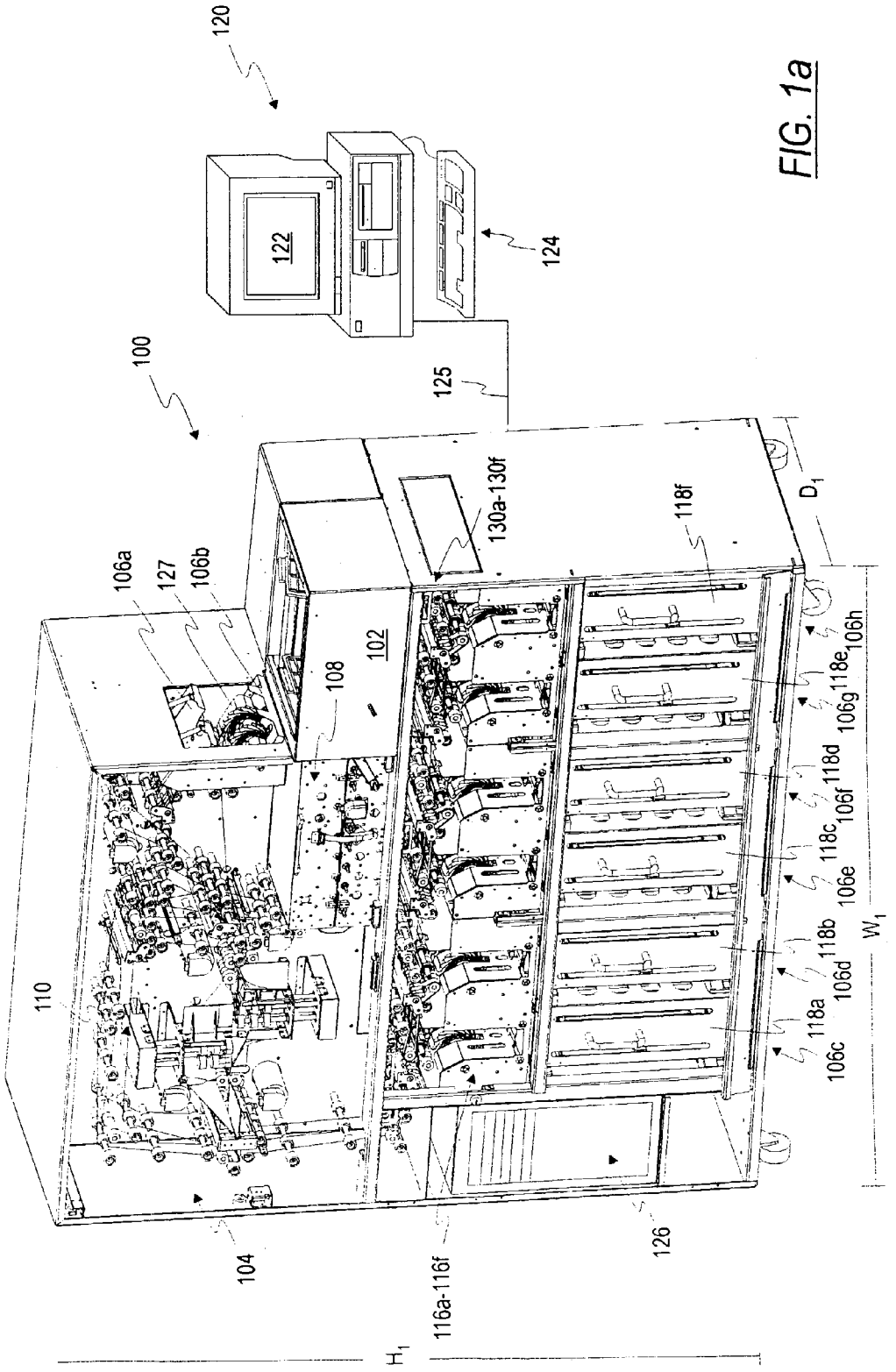
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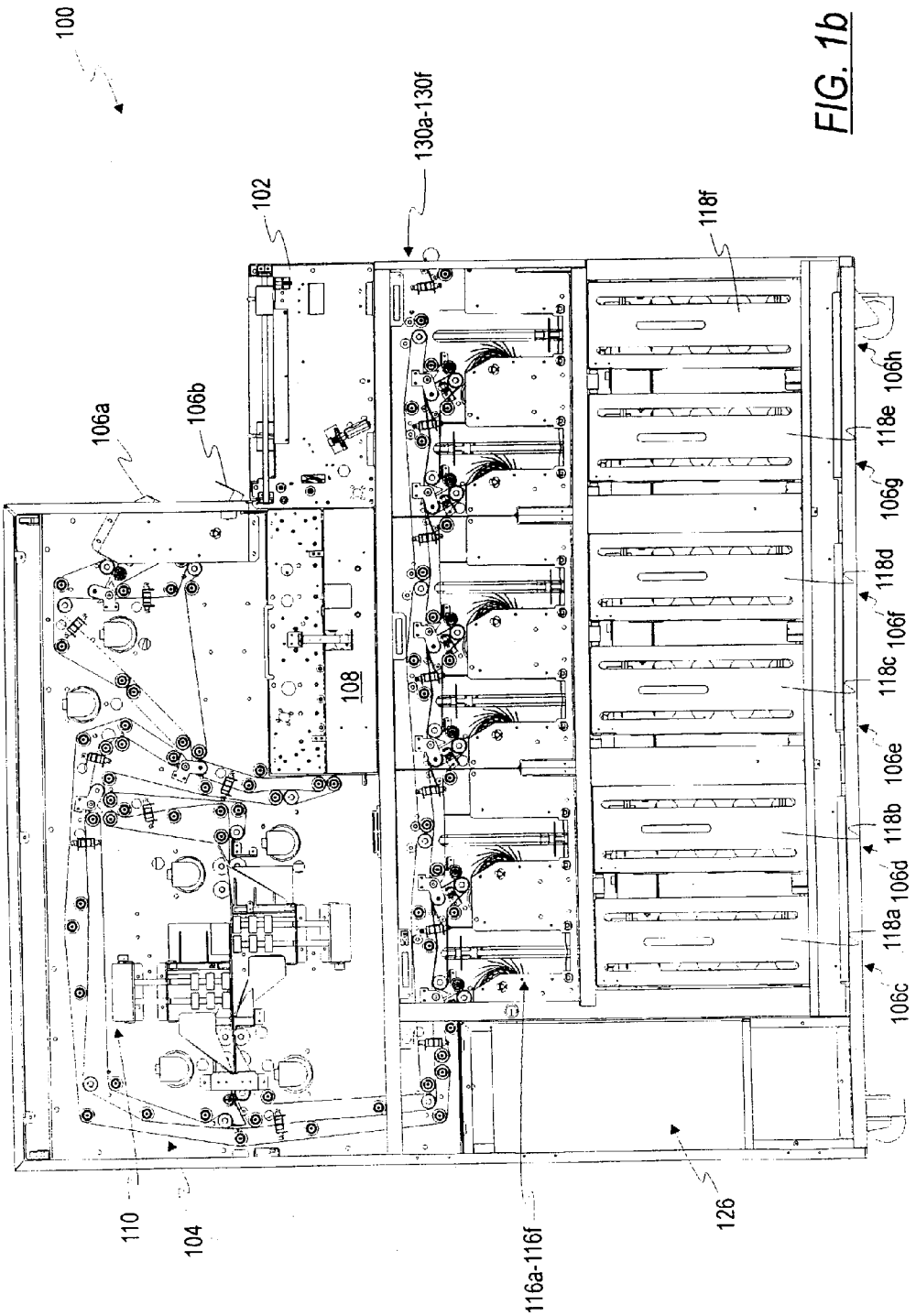
122
124
100
125
130a-130f
118f
D_1
106a
127
106b
102
108
106h
118e
106g
118d
106f
118c
106e
118b
106d
118a
106c
W_1
110
104
116a-116f
126
H_1

FIG. 1a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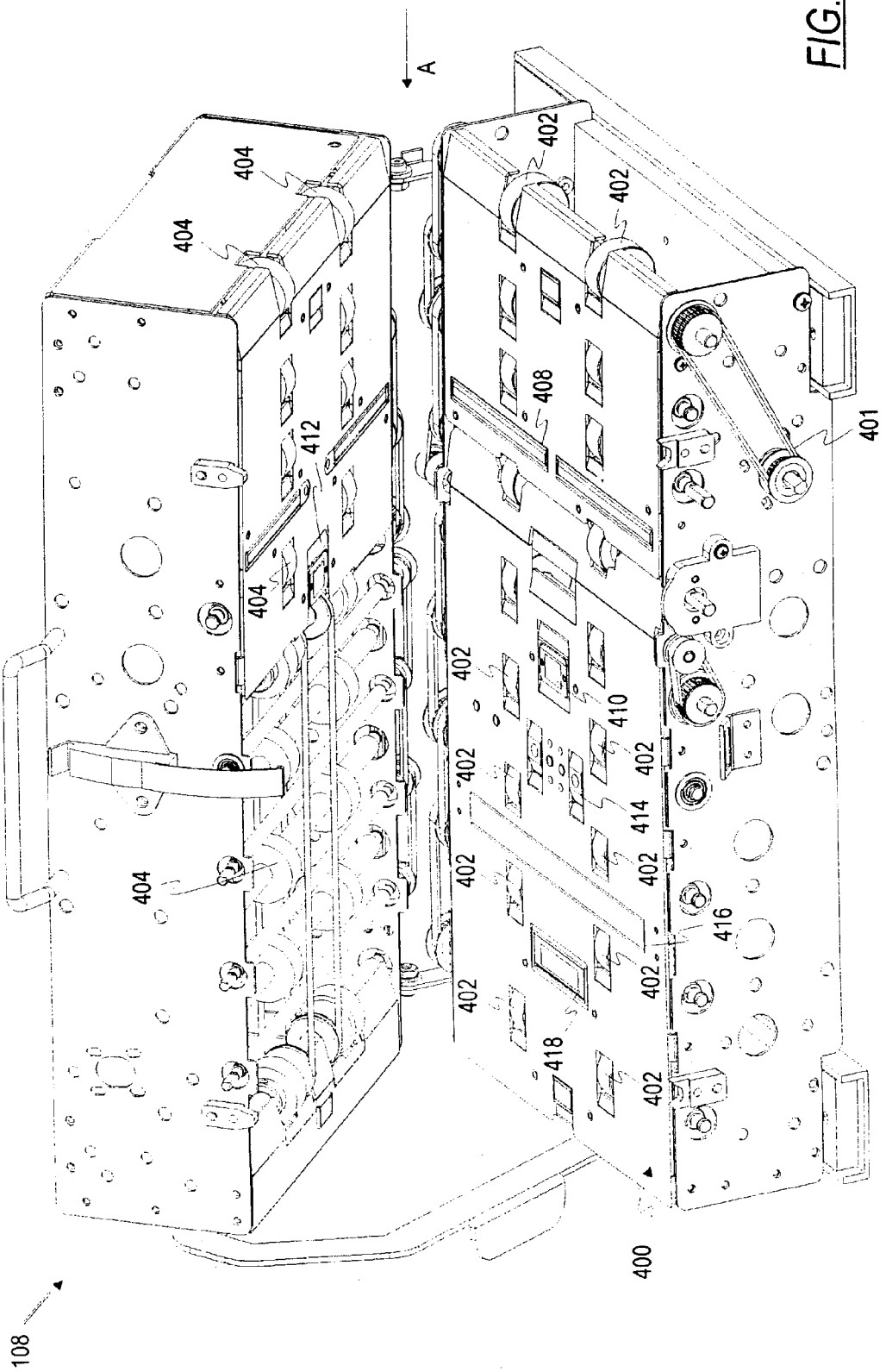
102
118f
106a
106b
106h
118e
106g
118d
106f
118c
106e
118b
106d
118a
106c
108
110
104
116a-116f
126

FIG. 1b

FIG. 2a



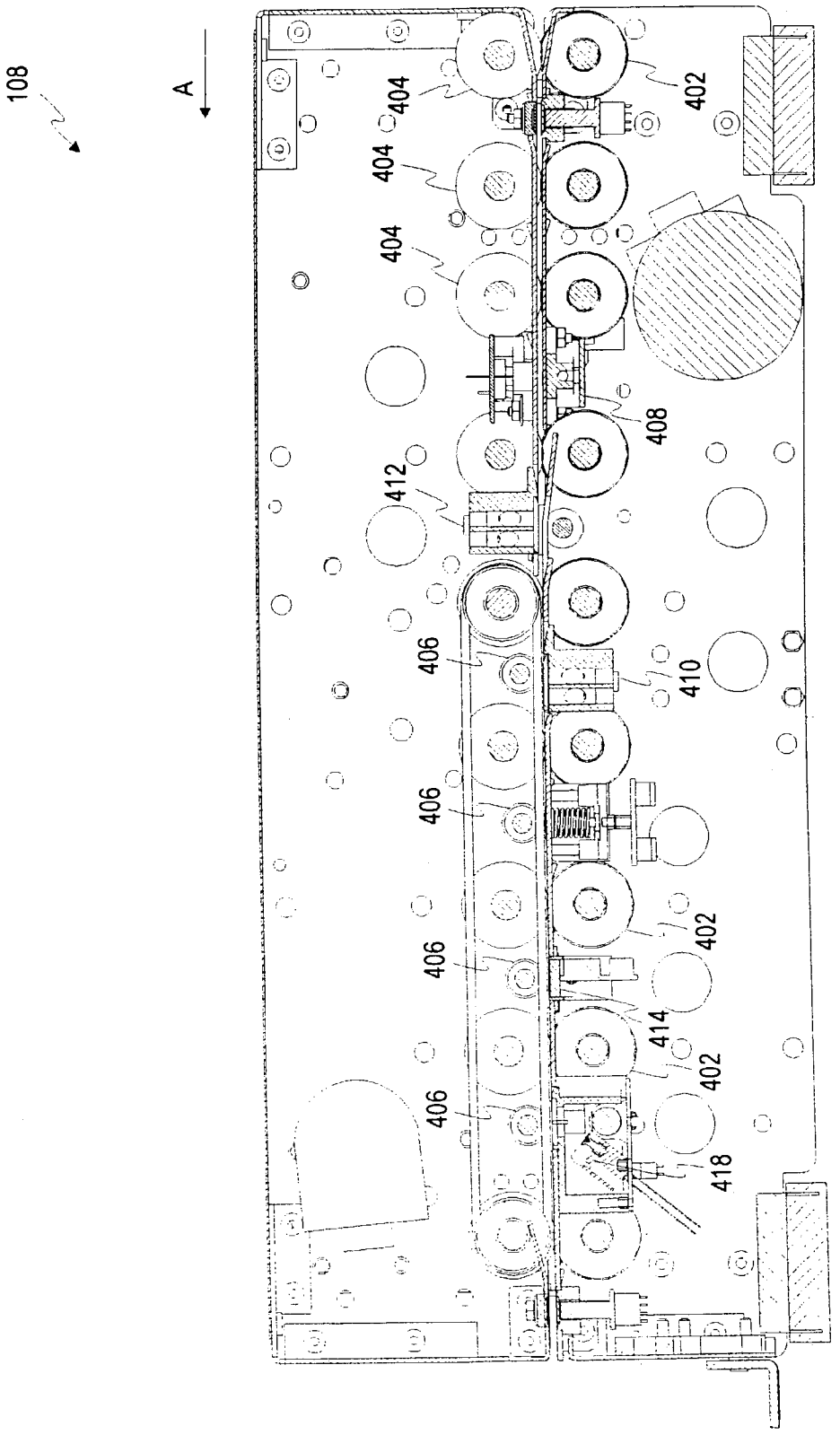
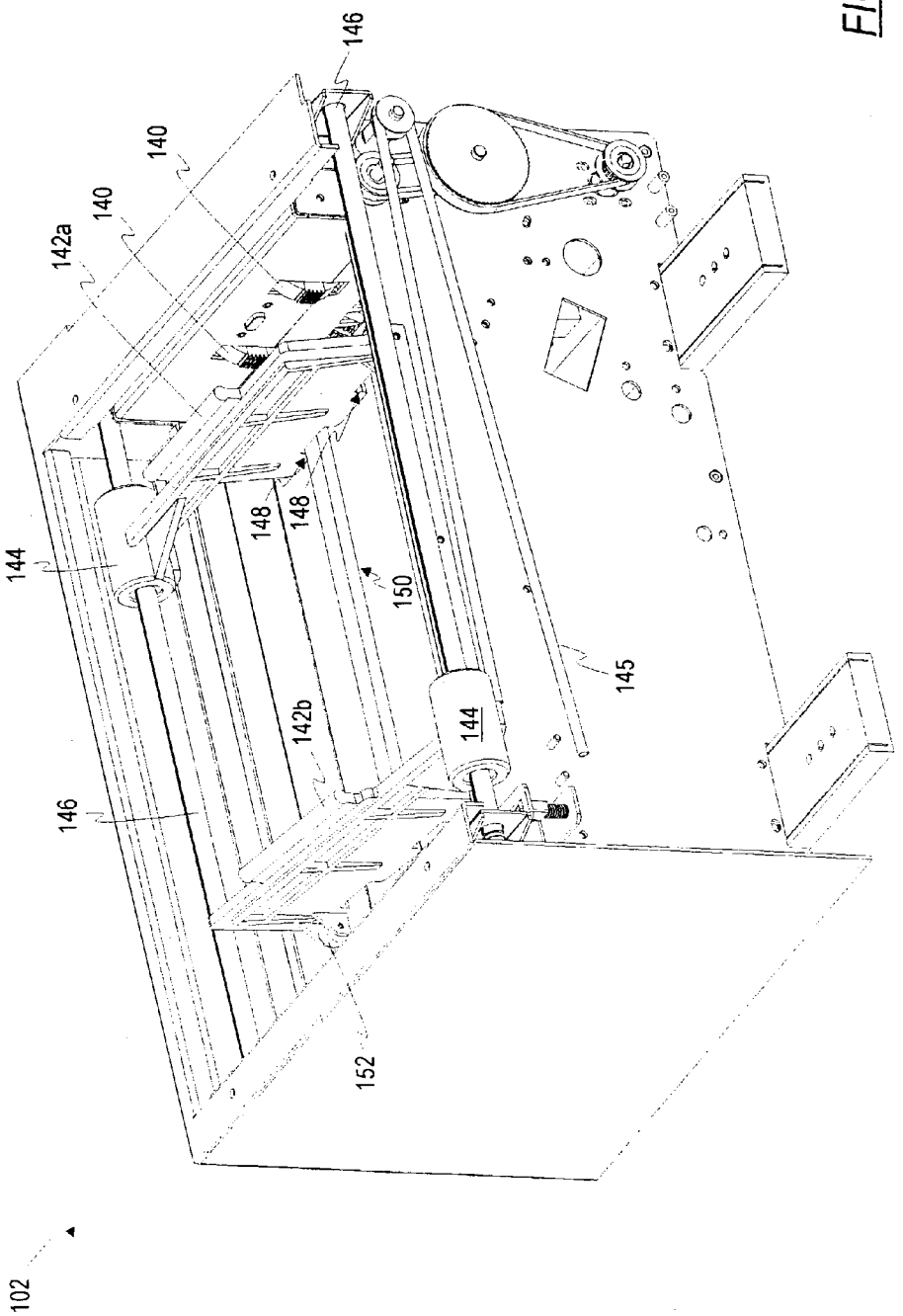


FIG. 2b

FIG. 3a



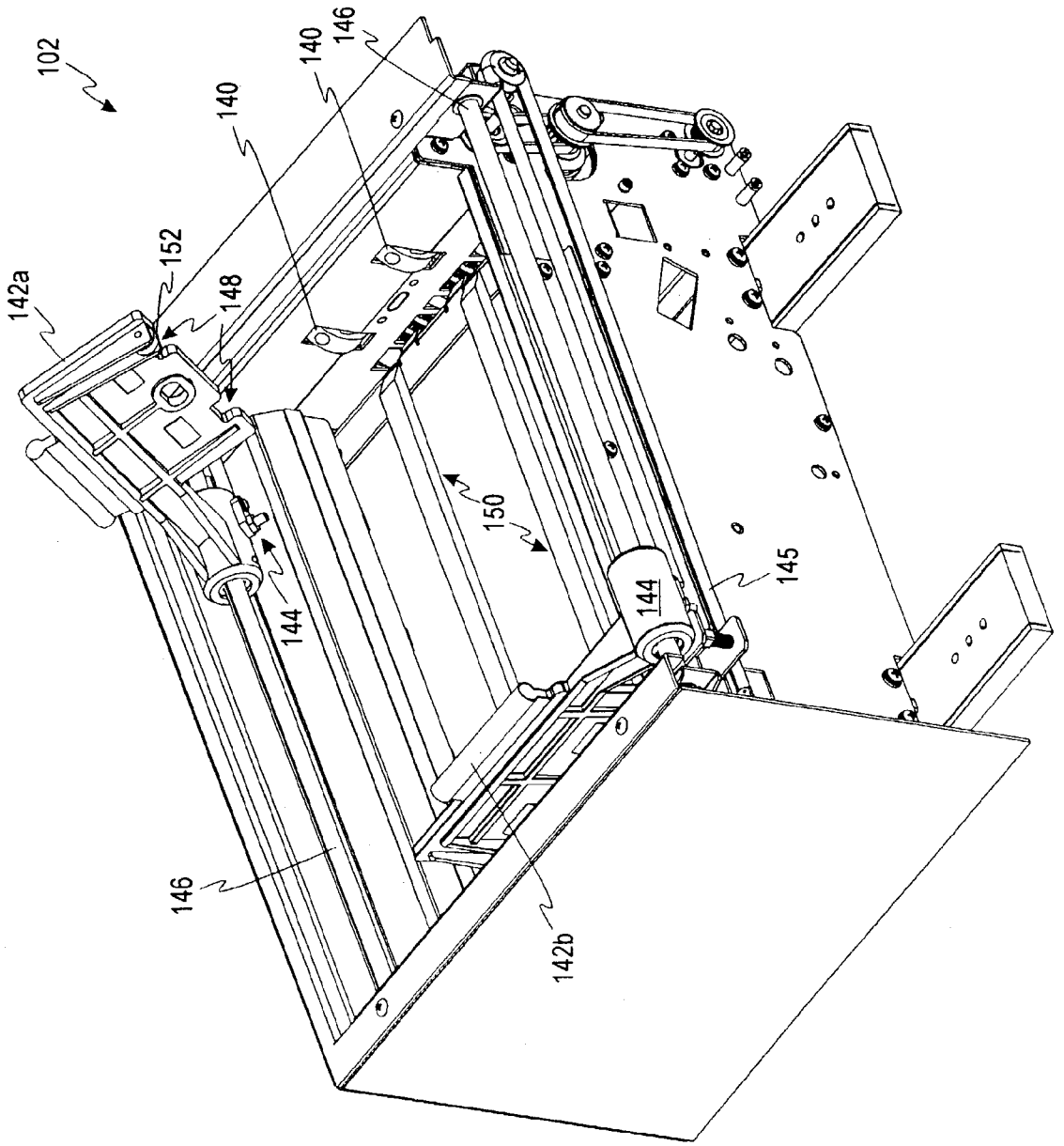


FIG. 3b

FIG. 3c

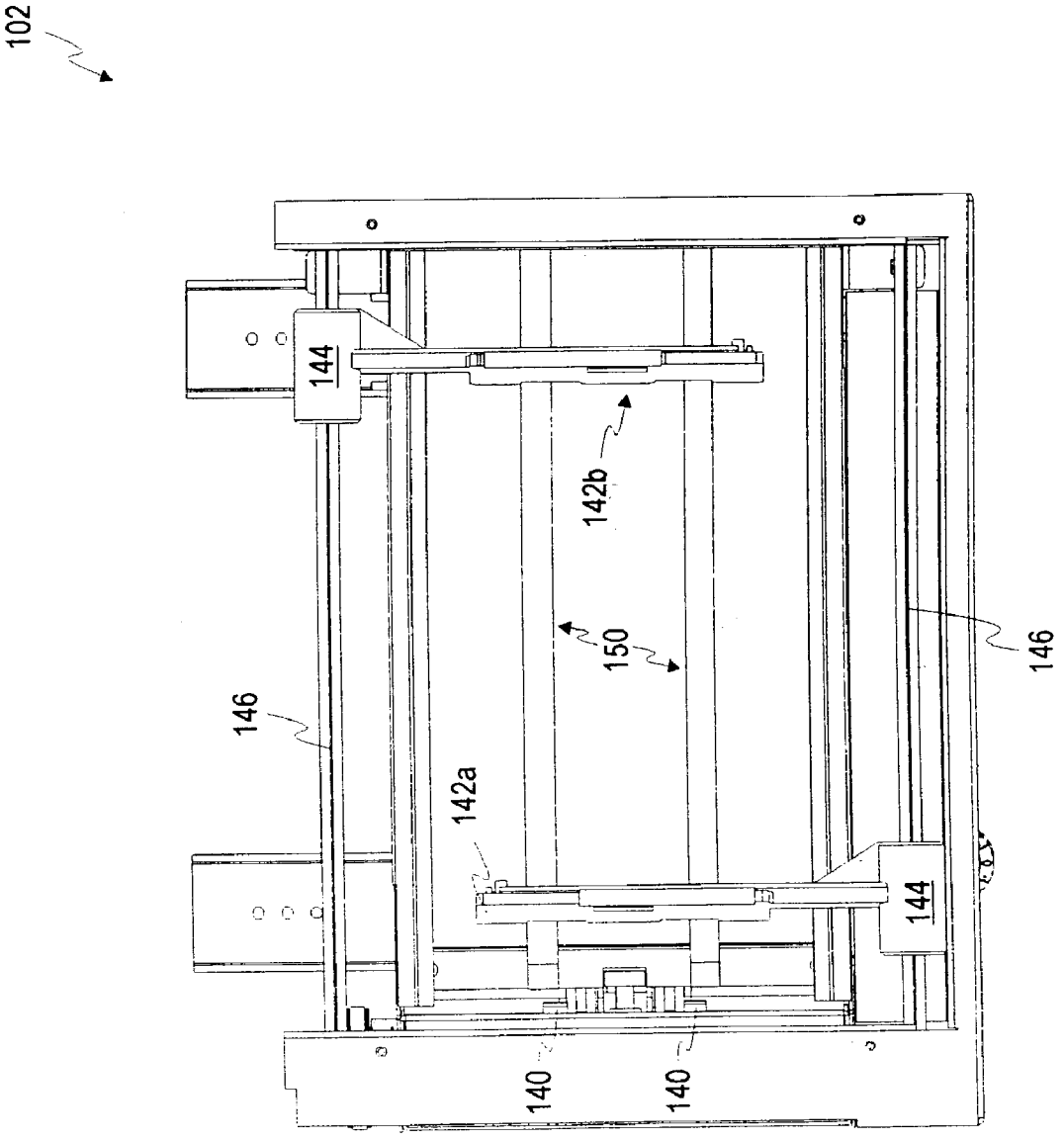
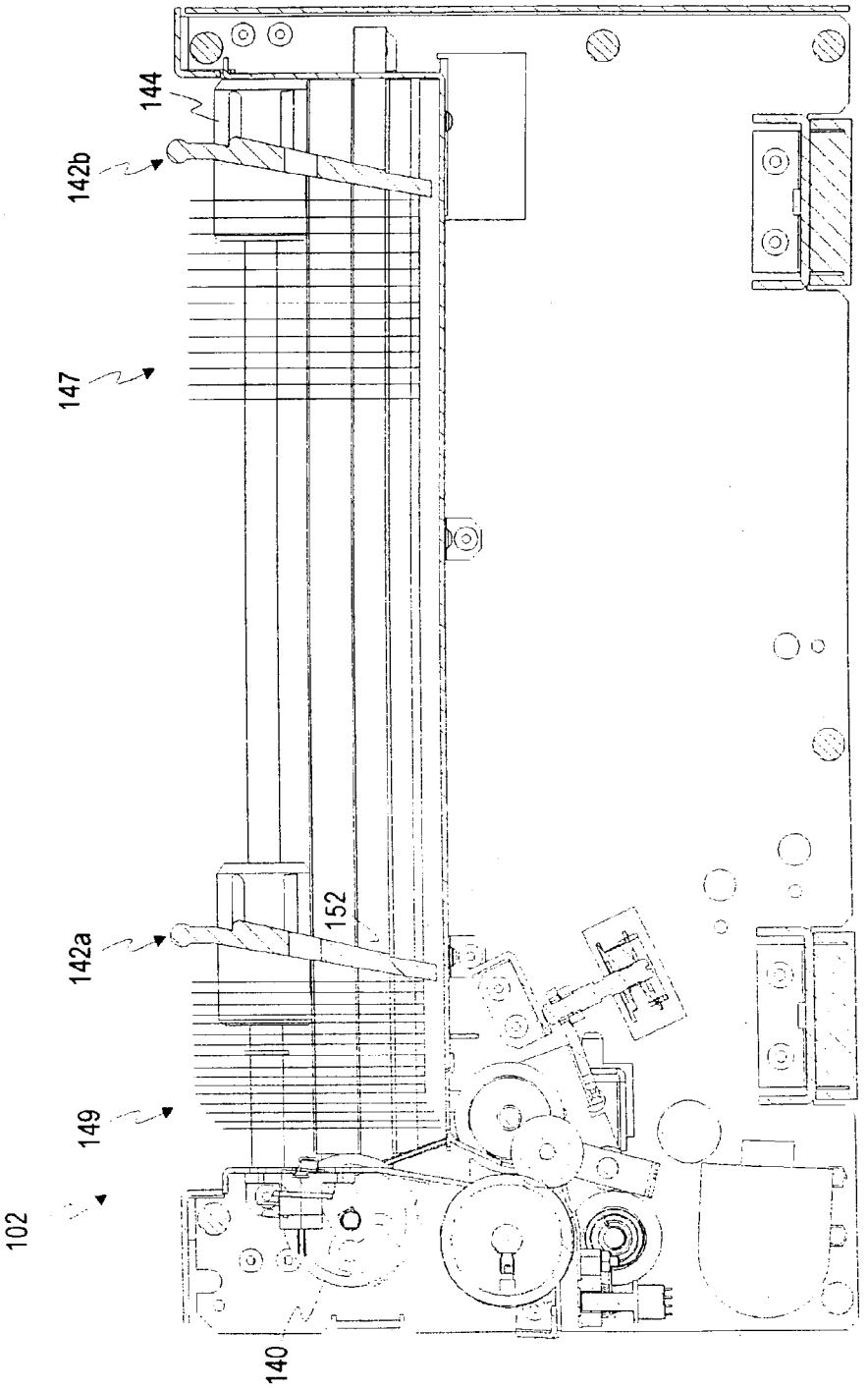


FIG. 3d



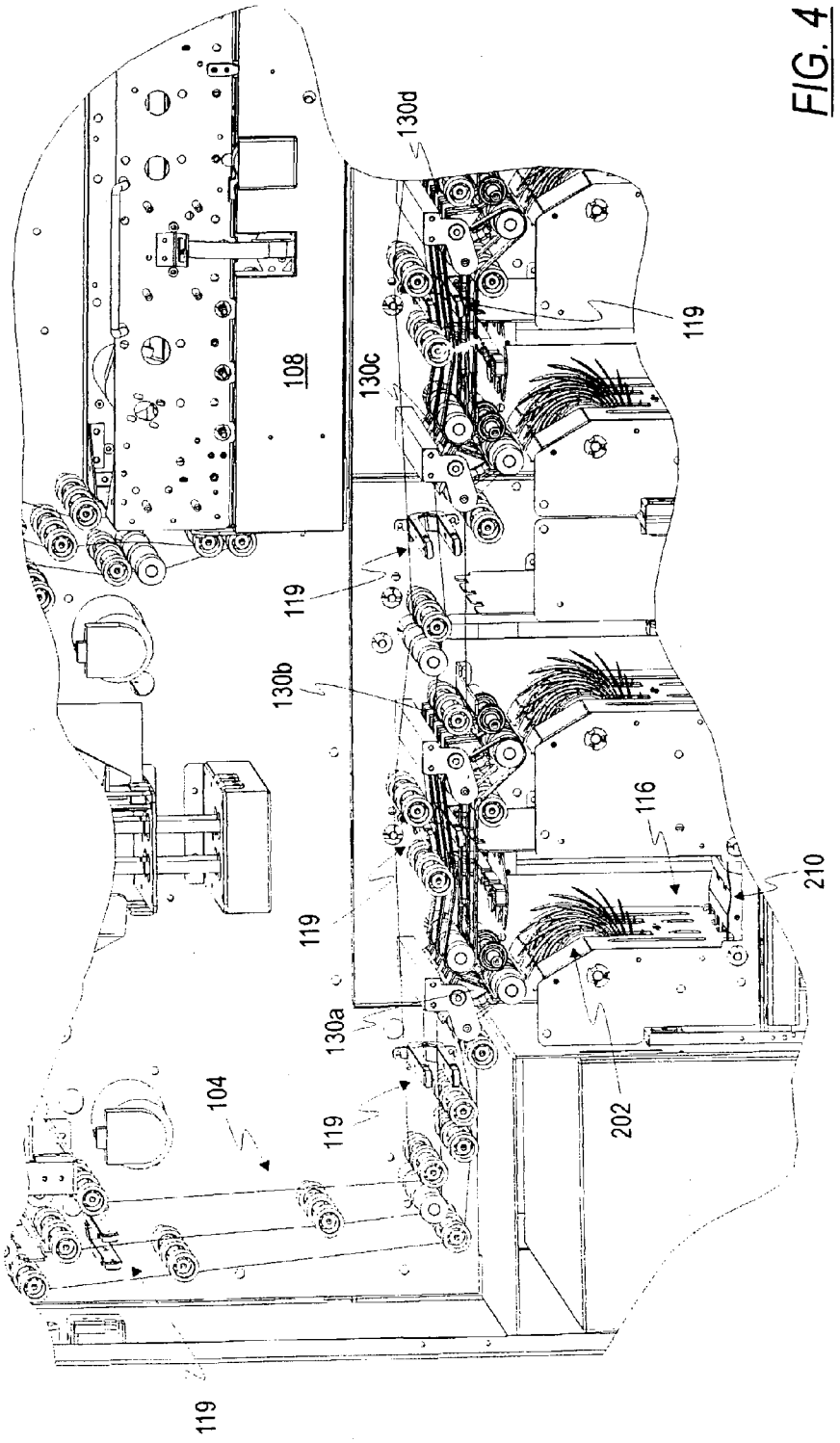


FIG. 4

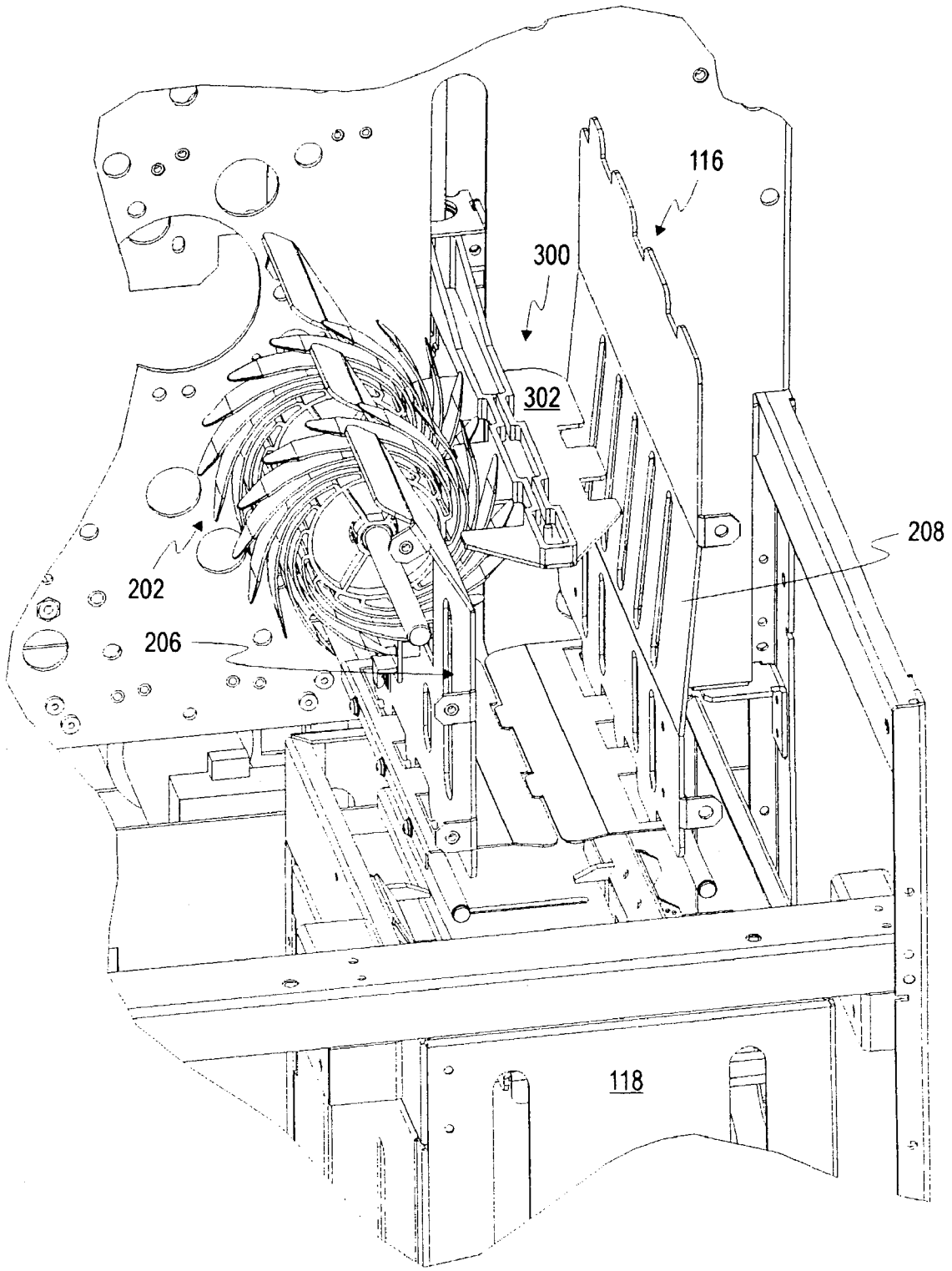


FIG. 5

FIG. 6

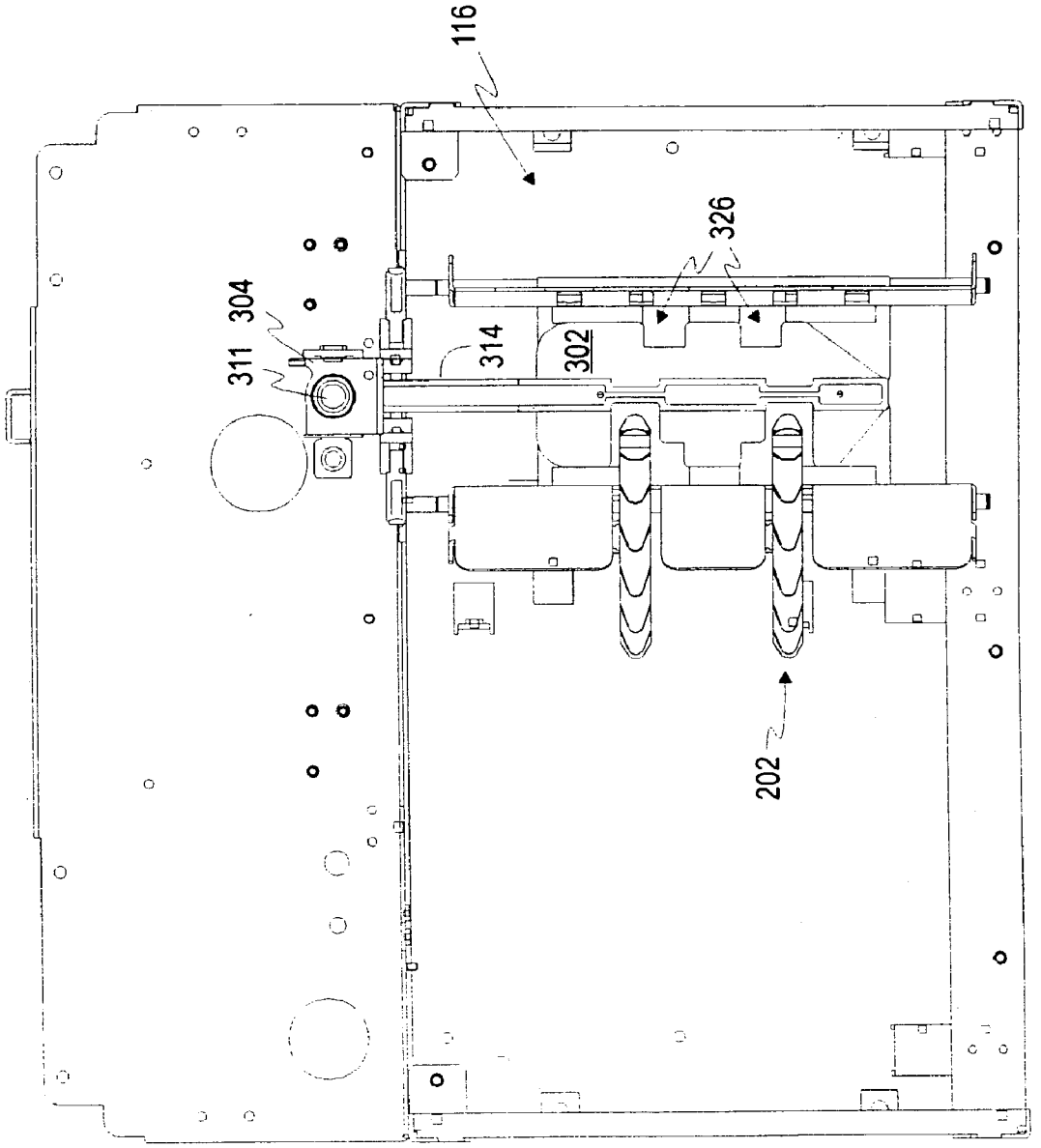
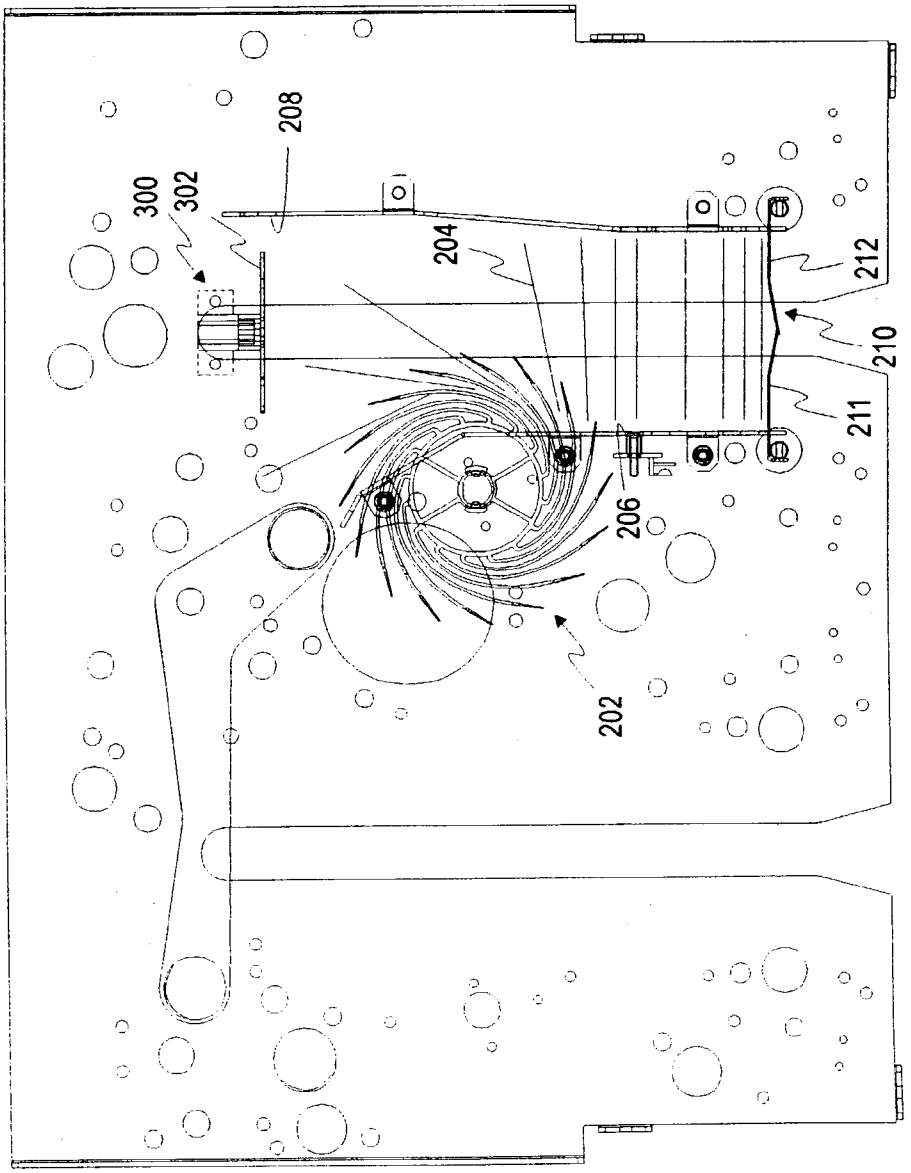


FIG. 7



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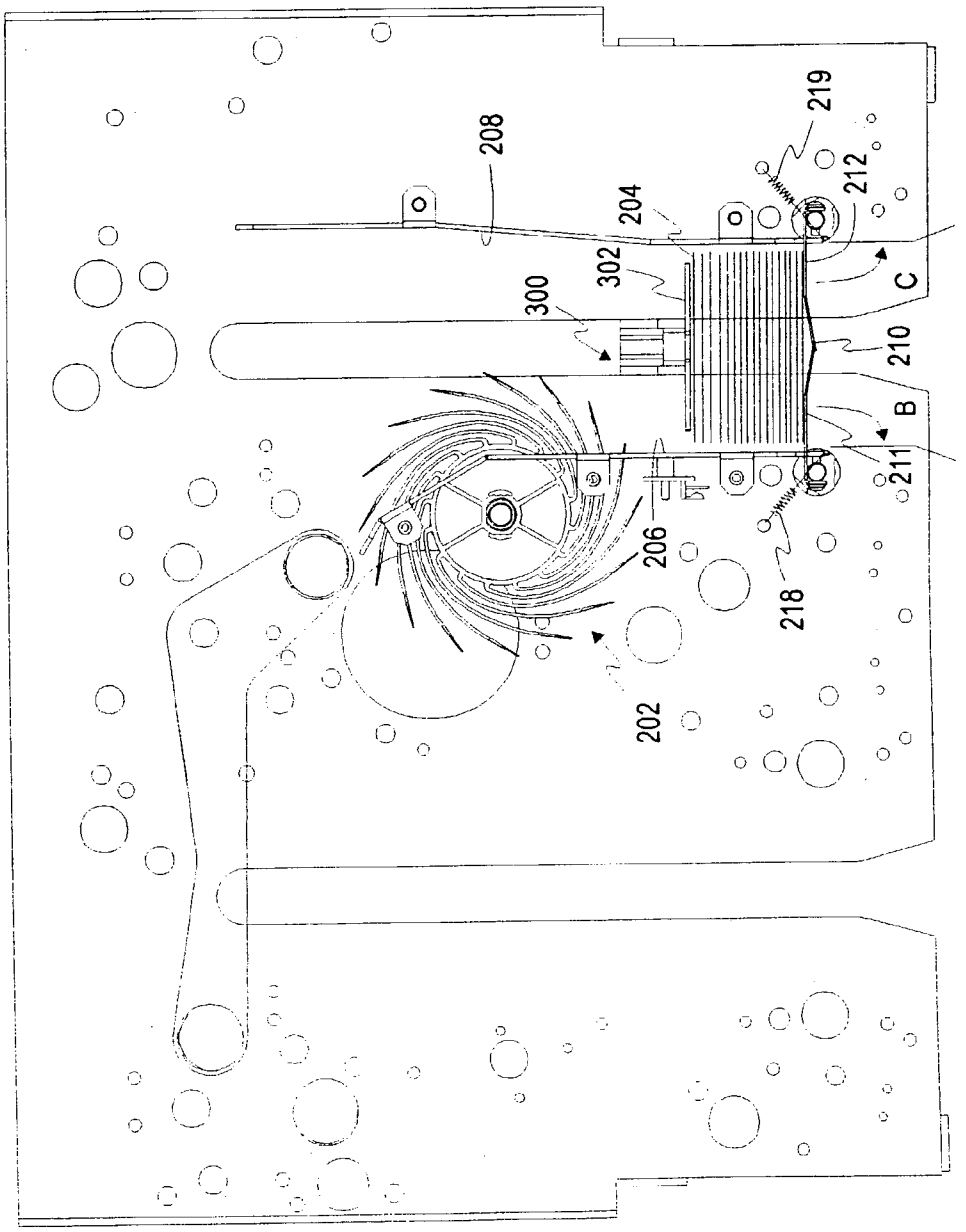

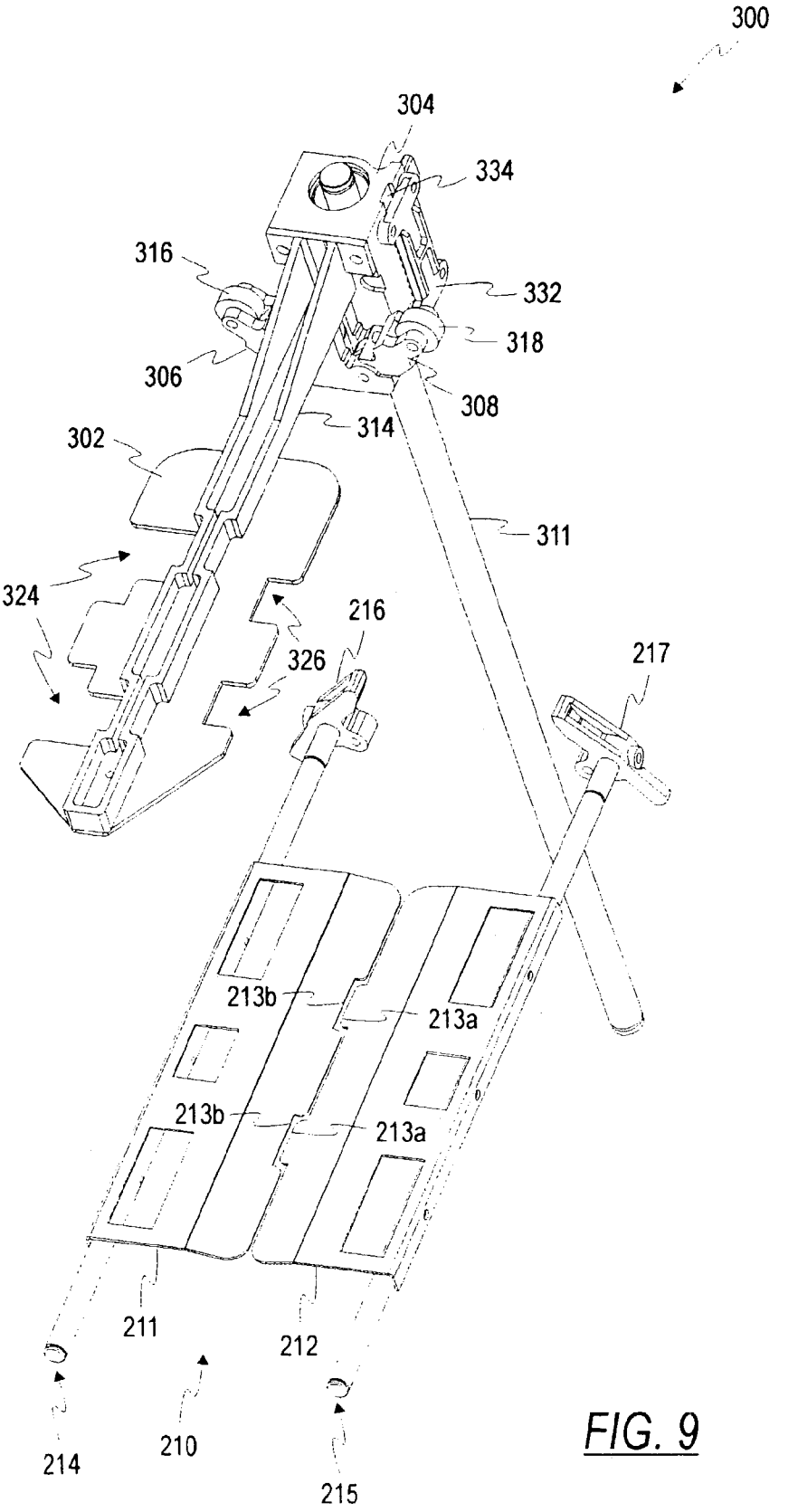
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FIG. 9

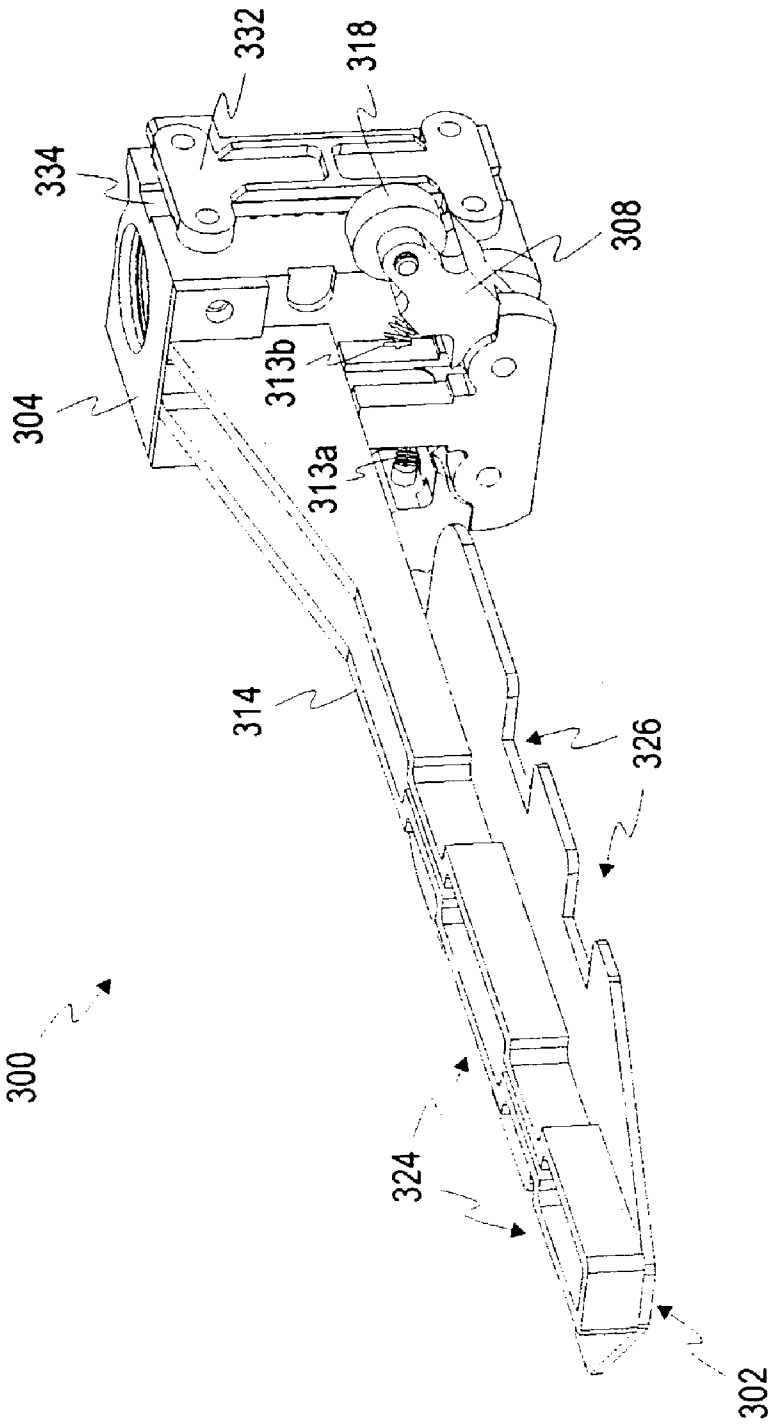


FIG. 10

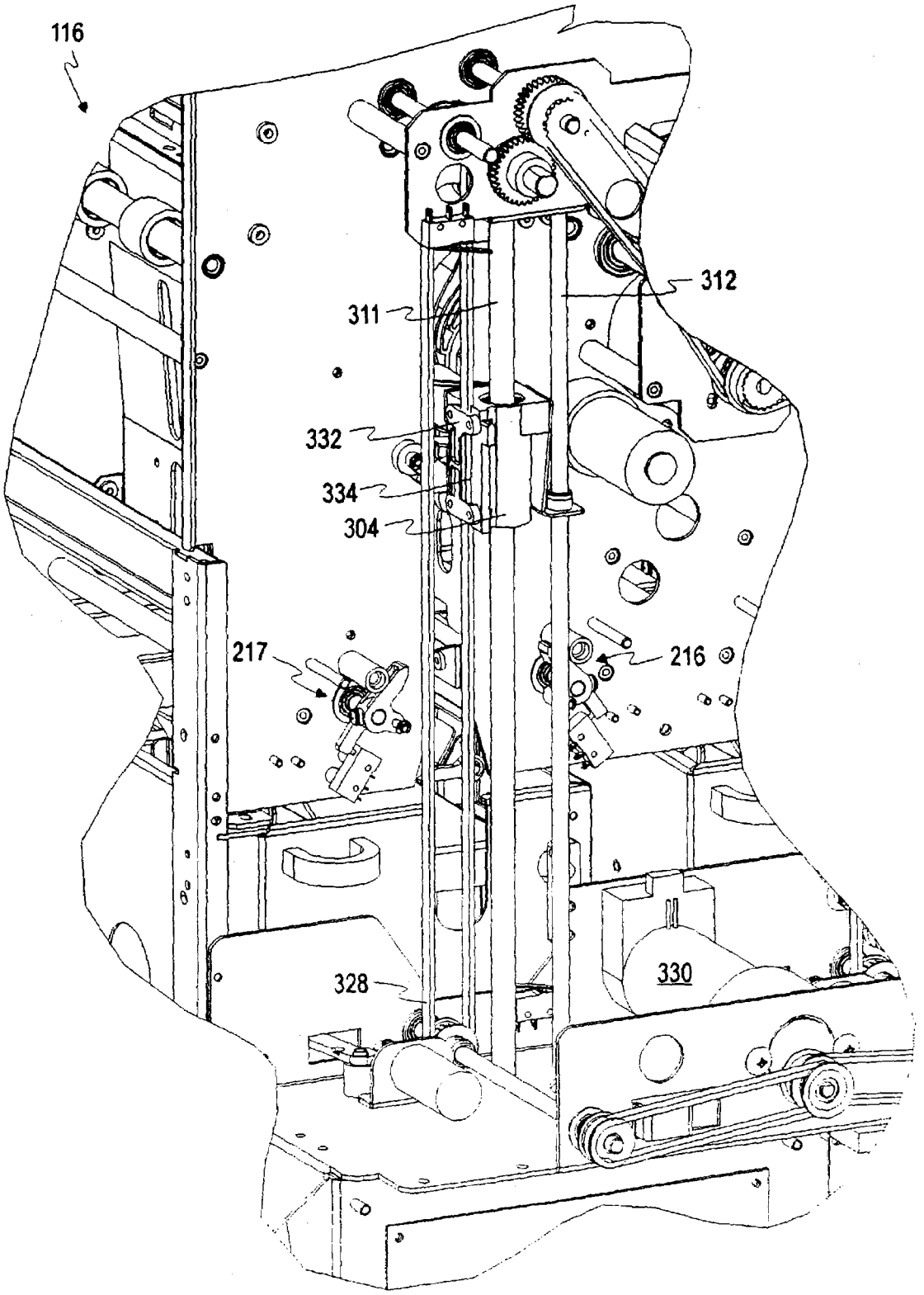


FIG. 11

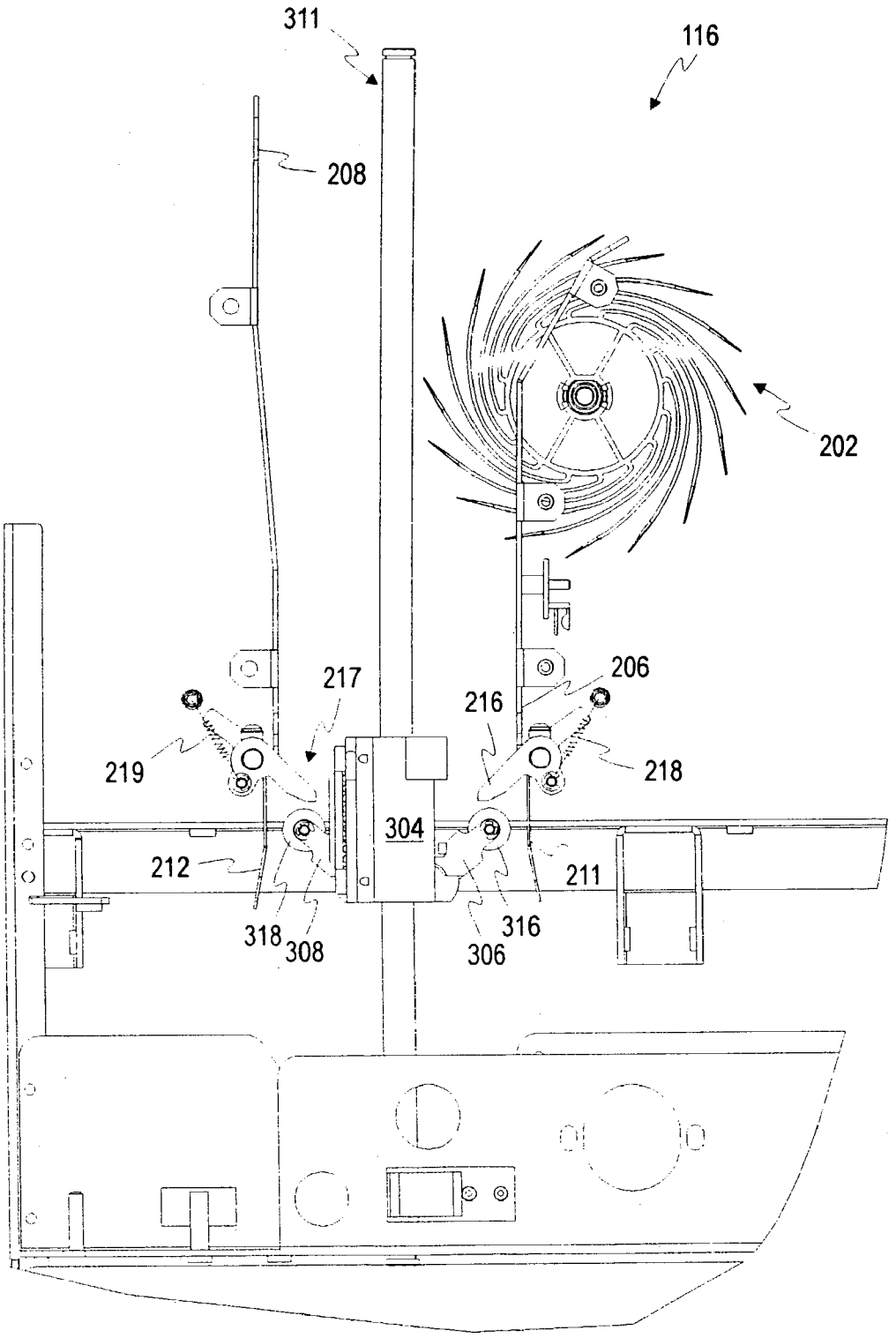


FIG. 12

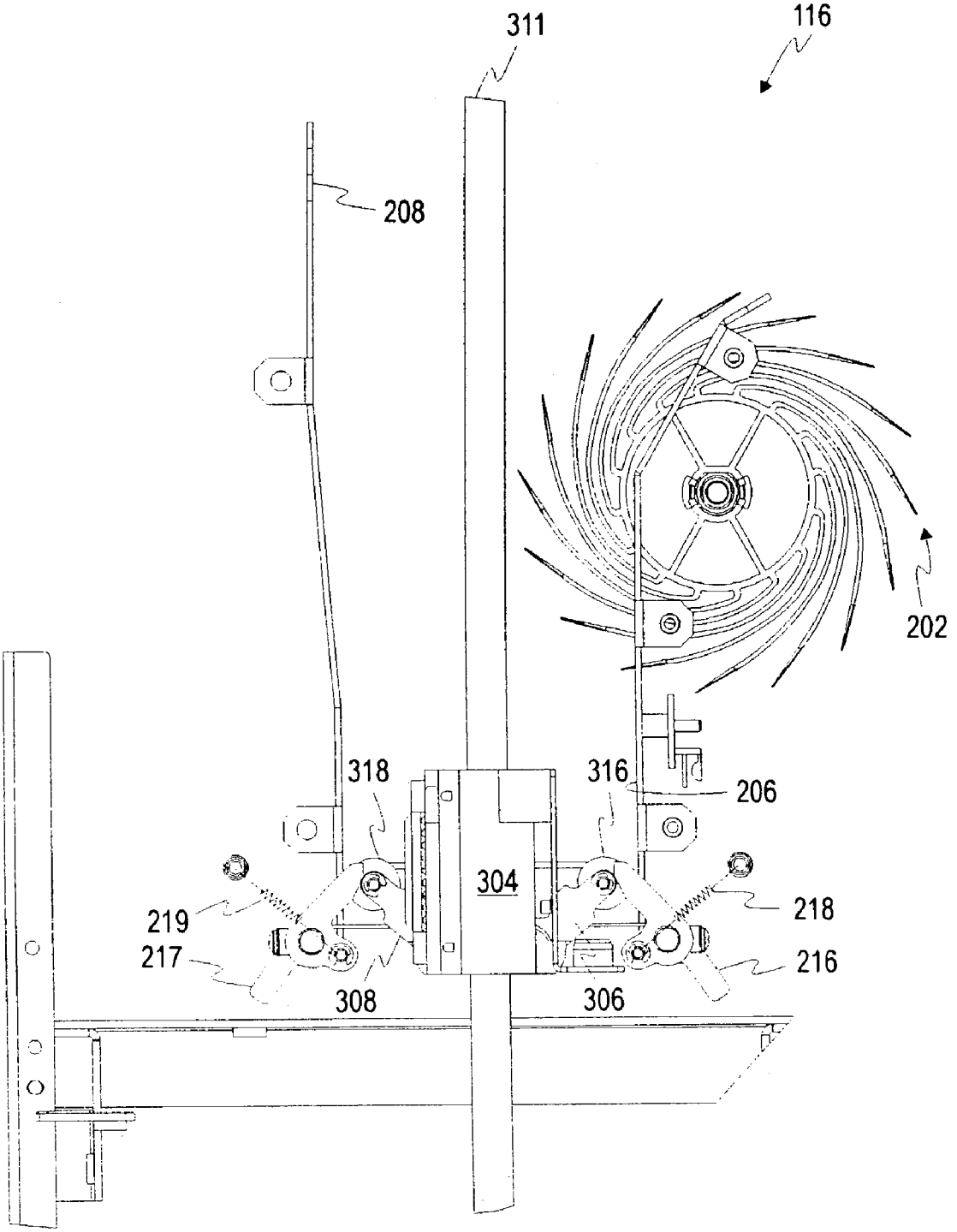


FIG. 13

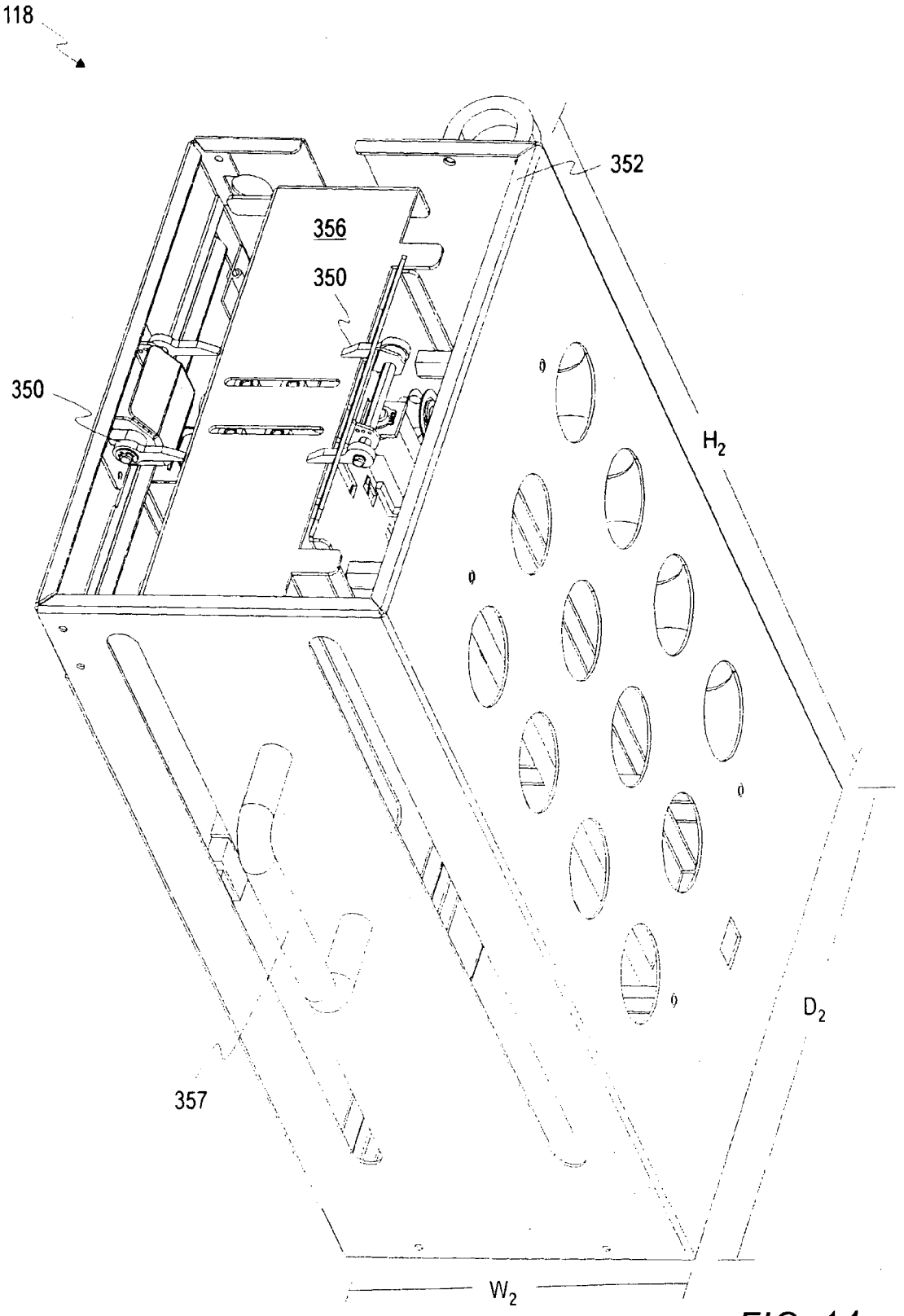
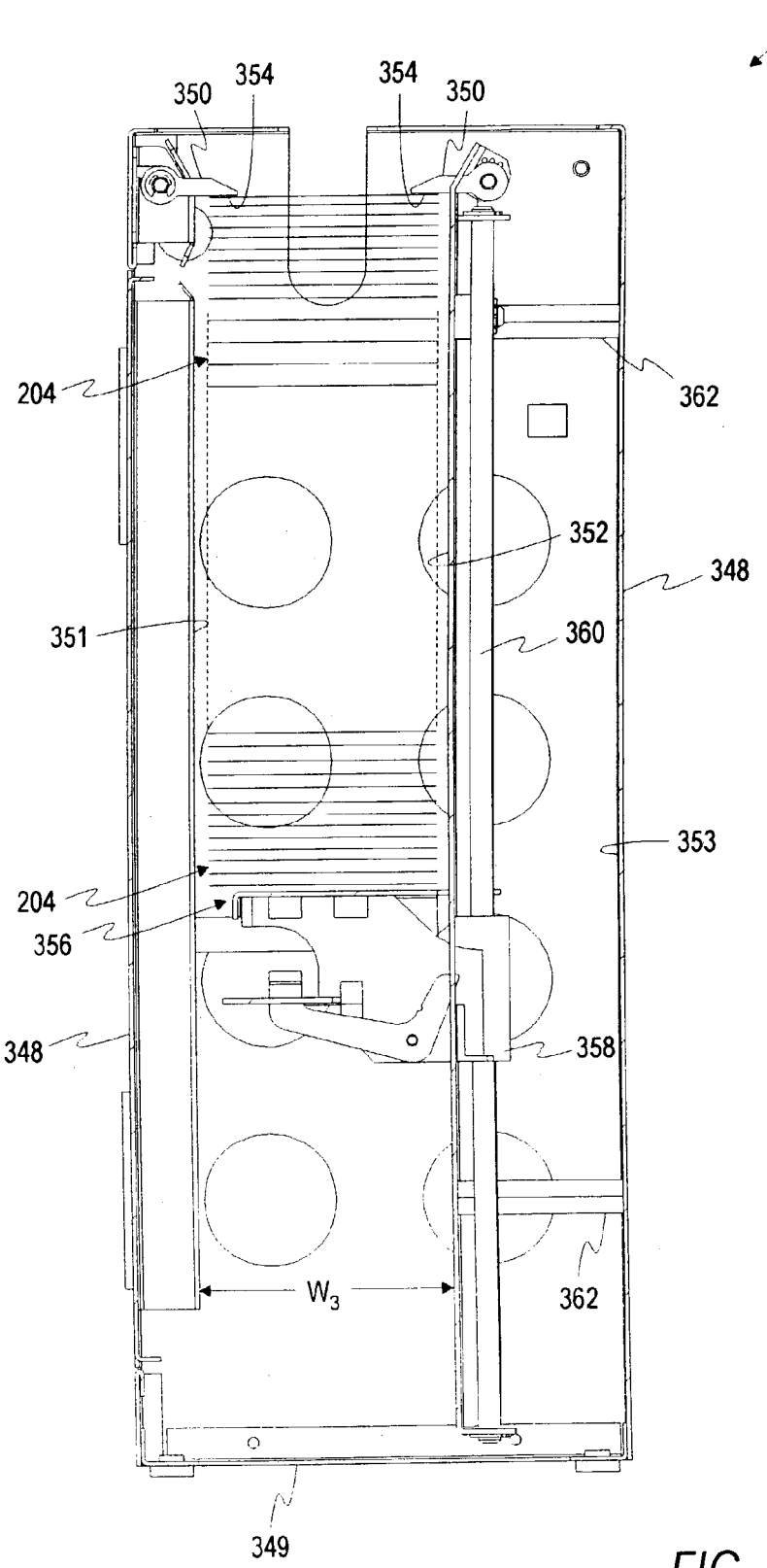


FIG. 14


118
350
354
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204
362
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W_3
362
349

FIG. 15

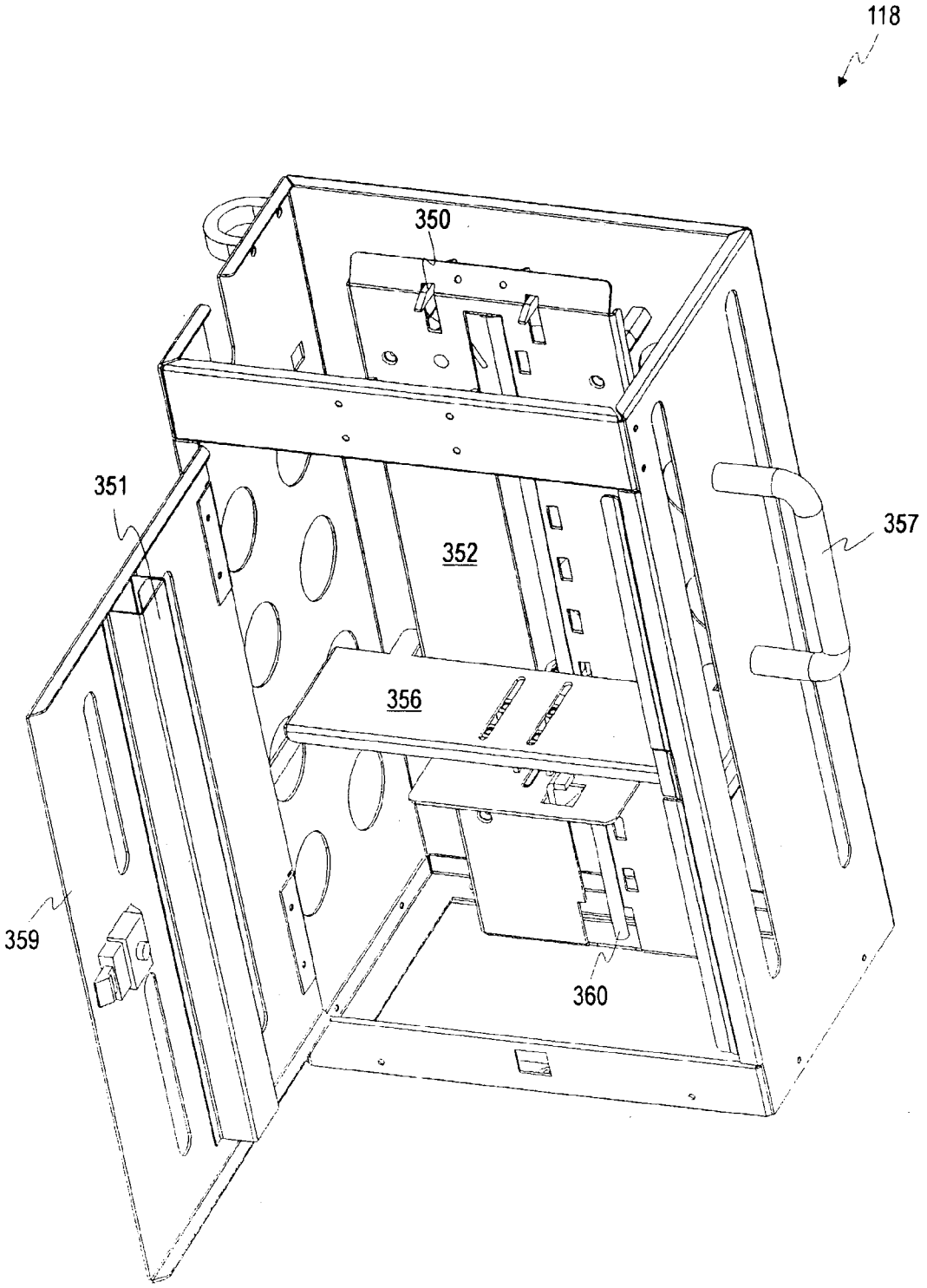


FIG. 16

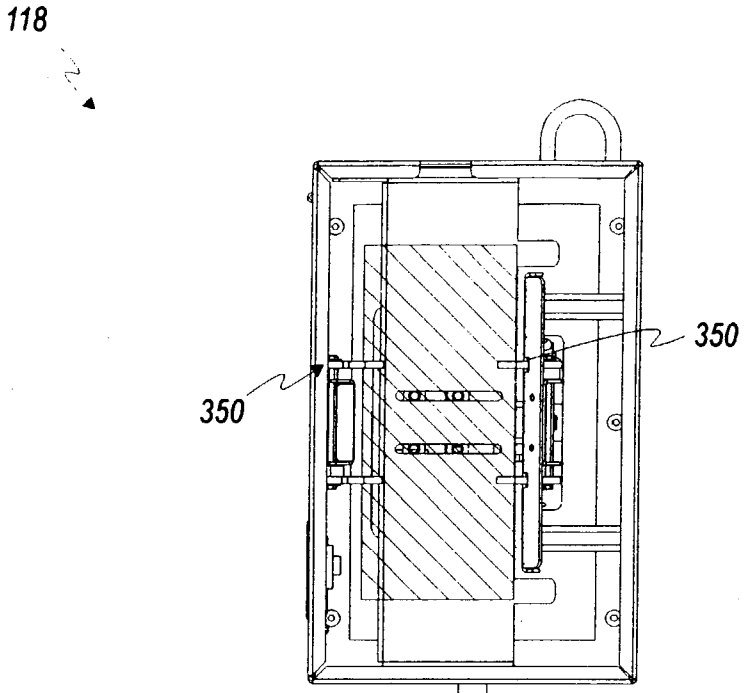


FIG. 17a

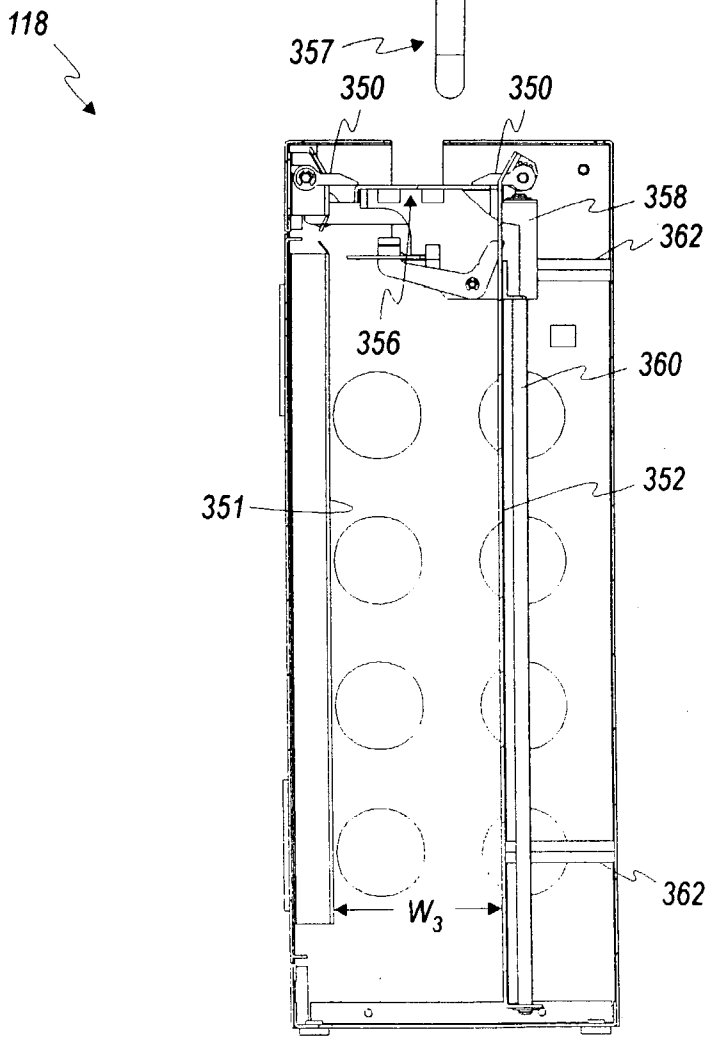


FIG. 17b

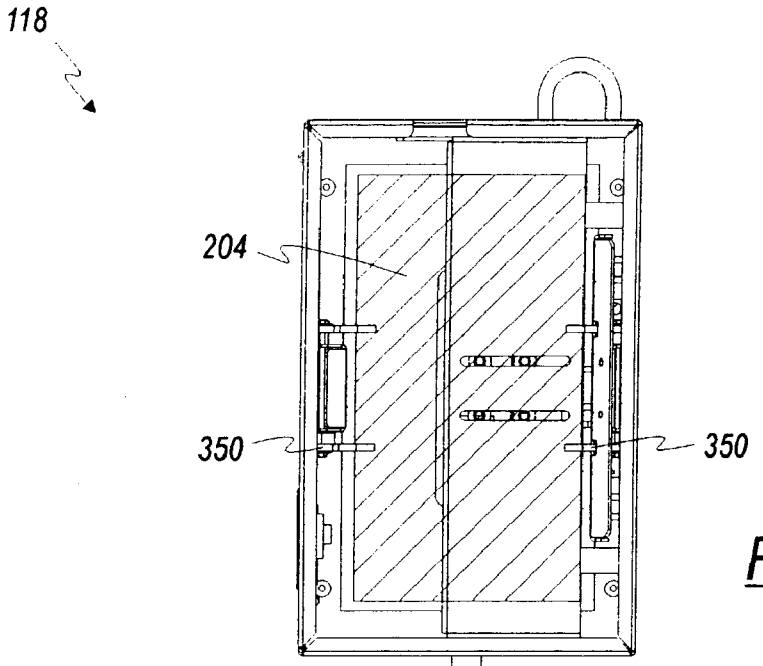


FIG. 18a

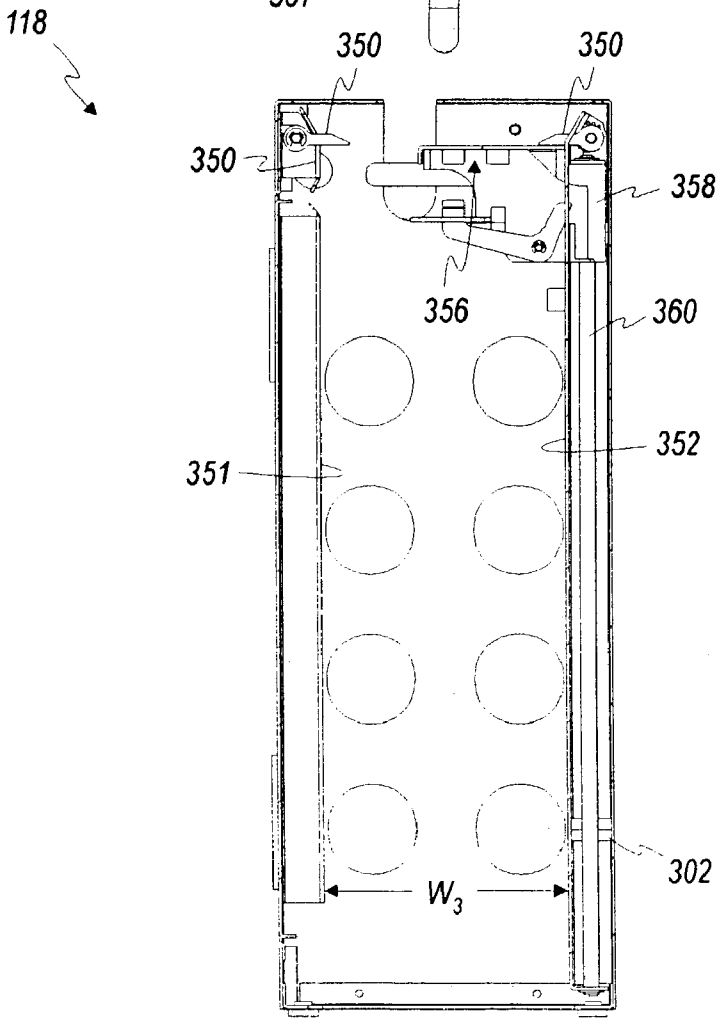
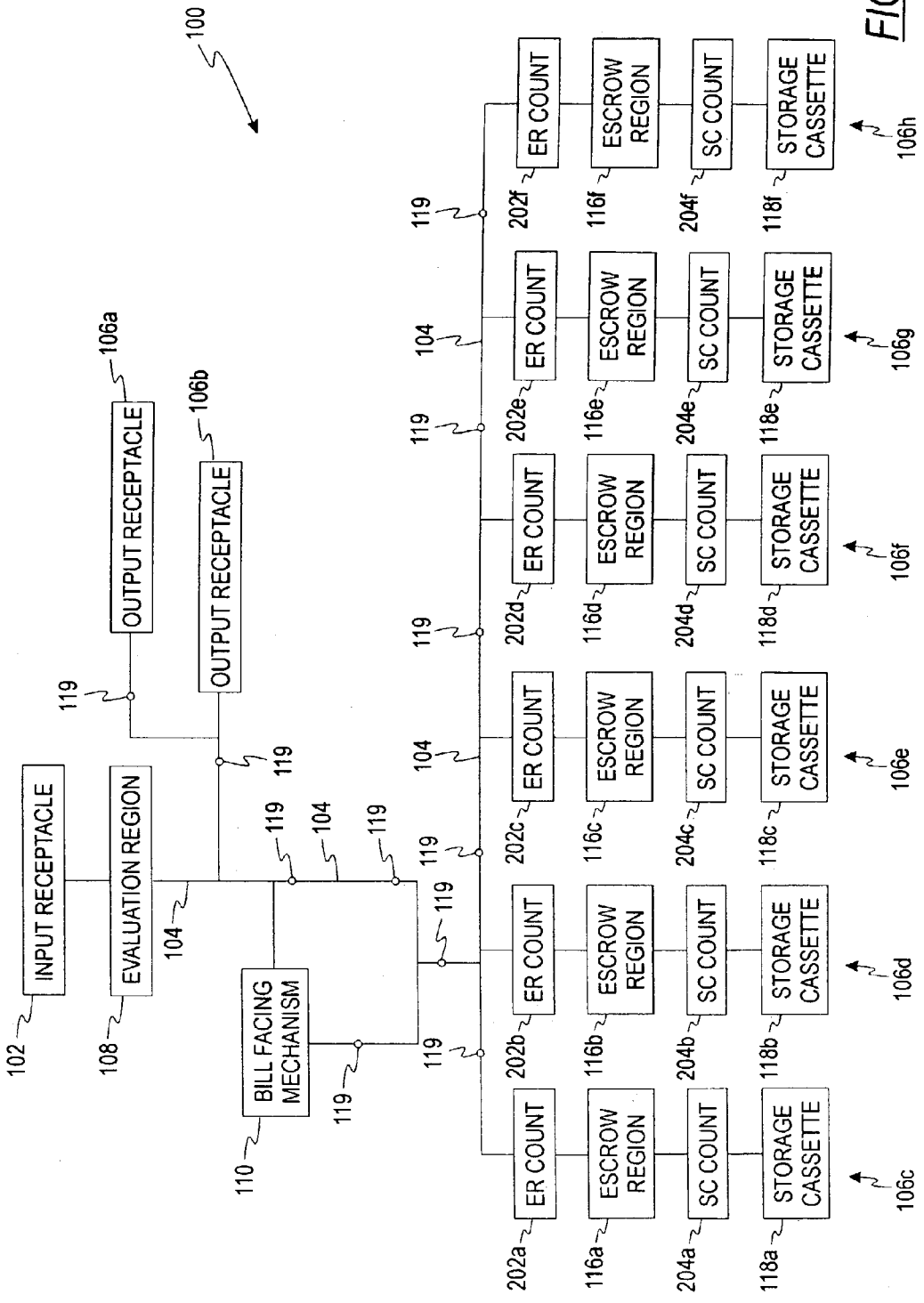


FIG. 18b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INPUT RECEPTACLE
102
EVALUATION REGION
108
BILL FACING MECHANISM
110
OUTPUT RECEPTACLE
106a
OUTPUT RECEPTACLE
106b
104
119
ER COUNT
202a
ESCROW REGION
116a
SC COUNT
204a
STORAGE CASSETTE
118a
106c
202b
116b
204b
118b
106d
202c
116c
204c
118c
106e
202d
116d
204d
118d
106f
202e
116e
204e
118e
106g
202f
116f
204f
118f
106h

FIG. 19

CURRENCY HANDLING SYSTEM HAVING MULTIPLE OUTPUT RECEPTACLES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 09/688,526, entitled "Currency Handing System Having Multiple Output Receptacles," which was filed on Oct. 16, 2000 now U.S. Pat. No. 6,588,569, and which is hereby incorporated by reference in its entirety.

U.S. application Ser. No. 09/688,526 is a continuation-in-part of U.S. patent application Ser. No. 09/502,666, entitled "Currency Handling System Having Multiple Output Receptacles," which was filed on Feb. 11, 2000 U.S. patent application Ser. No. 09/502,666 issued as U.S. Pat. No. 6,398,000 on Jun. 4, 2002.

FIELD OF THE INVENTION

The present invention relates generally to the field of currency handling systems and, more particularly, to a multi-pocket currency handling system for discriminating, authenticating, and/or counting currency bills.

BACKGROUND OF THE INVENTION

A variety of techniques and apparatuses have been used to satisfy the requirements of automated currency handling machines. As businesses and banks grow, these businesses are experiencing a greater volume of paper currency. These businesses are continually requiring not only that their currency be processed more quickly but, also, processed with more options in a less expensive manner. At the upper end of sophistication in this area of technology are machines that are capable of rapidly identifying, discriminating, and counting multiple currency denominations and then delivering the sorted currency bills into a multitude of output compartments. Many of these high end machines are extremely large and expensive such that they are commonly found only in large institutions. These machines are not readily available to businesses which have monetary and space budgets, but still have the need to process large volumes of currency. Other high end currency handling machines require their own climate controlled environment which may place even greater strains on businesses having monetary and space budgets.

Currency handling machines typically employ magnetic sensing or optical sensing for denominating and authenticating currency bills. The results of these processes determines to which output compartment a particular bill is delivered to in a currency handling device having multiple output receptacles. For example, ten dollar denominations may be delivered to one output compartment and twenty dollar denominations to another, while bills which fail the authentication test are delivered to a third output compartment. Unfortunately, many prior art devices only have one output compartment which can be appropriately called a reject pocket. Accordingly, in those cases, the reject pocket may have to accommodate those bills which fail a denomination test or authentication test. As a result, different types of "reject" bills are stacked upon one another in the same output compartment leaving the operator unknowing as to which of those bills failed which tests.

Many prior art large volume currency handling devices which positively transport the currency bills through the device are susceptible to becoming jammed. And many of these machines are difficult to un-jam because the operator must physically remove the jammed bill or bills from the device. If necessary, the operator can sometimes manipulate a hand-crank to manually jog the device to remove the bills. Then, the operator must manually turn the hand crank to flush out all the bills from within the system before the batch can be reprocessed. Further compounding the problem in a bill jam situation is that many prior art devices are not equipped to detect the presence of a bill jam. In such a situation, the device continues to operate until the bills pile up and the bill jam is so severe that the device is physically forced to halt. This situation can cause physical damage to both the machine and the bills.

Often, a bill jam ruins the integrity of the count and/or valuation of the currency bills requiring that the entire batch, including those bill already processed into holding and/or storage areas, be reprocessed. Bills need to be reprocessed because prior art devices do not maintain several running totals of bills as bills pass various points within the device. Removing bills from the holding areas and/or storage areas is a time consuming process. For example, a prior device may only count the bills as they are transported through an evaluation region of the currency handing machine. Bills exiting the evaluation region are included in the totals regardless of whether they are involved in bill jams or are successfully transported to an output receptacle. Therefore, when a bill jam occurs those bills involved in the bill jam as well as those bills already transported to the storage areas and/or storage areas have to be reprocessed.

SUMMARY OF THE INVENTION

A method and apparatus for handling bill jams within a currency processing device is provided. The device includes a transport mechanism adapted to transport bills along a transport path, one at a time, from the input receptacle past an evaluation unit into a plurality of output receptacles. At least one of the output receptacles includes a holding area and a storage area. A plurality of bill passage sensors are sequentially disposed along the transport path that are adapted to detect the passage of a bill as each bill is transported past each sensor. An encoder is adapted to produce an encoder count for each incremental movement of the transport mechanism. A controller counts the total number of bills transported into each of the holding areas and the total number of bills moved from a holding area to a corresponding storage area after a predetermined number of bills have been transported into the holding area. The controller tracks the movement of each of the bills along the transport path into each of the holding areas with the plurality of bill passage sensors. The presence of a bill jam is detected when a bill is not transported past one of the plurality of bill passage sensors within a requisite number of encoder counts. The operation of the transport mechanism is suspended upon detection of a bill jam. The bills from each of the holding areas are moved to the corresponding storage areas upon suspension of the operation of the transport mechanism. Remaining bills are then flushed from the transport path after moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism.

The above summary of the present invention is not intended to represent each embodiment, or every aspect, of the present invention. Additional features and benefits of the present invention will become apparent from the detail description, figures, and claim set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description in conjunction with the drawings in which:

FIG. **1***a* is a perspective view of a document handling device according to one embodiment of the invention;

FIG. **1***b* is a front view of a document handling device according to one embodiment of the invention;

FIG. **2***a* is a perspective view of an evaluation region according to one embodiment of the document handling device of the present invention;

FIG. **2***b* is a side view of an evaluation region according to one embodiment of the document handling device of the present invention;

FIG. **3***a* is a perspective view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. **3***b* is another perspective view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. **3***c* is a top view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. **3***d* is a side view of an input receptacle according to one embodiment of the document handling device of the present invention;

FIG. **4** is a perspective view of a portion of a transportation mechanism according to one embodiment of the present invention;

FIG. **5** is a front perspective view of an escrow compartment, a plunger assembly, and a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **6** is a top view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. **7** is a front view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention,

FIG. **8** is another front view of an escrow compartment and plunger assembly according to one embodiment of the document handling device of the present invention;

FIG. **9** is a perspective view of an apparatus for transferring currency from an escrow compartment to a storage cassette according to one embodiment of the document handling device of the present invention,

FIG. **10** is a perspective view of a paddle according to one embodiment of the document handling device of the present invention;

FIG. **11** is a rear perspective view of the escrow compartment, plunger assembly, and storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **12** is a rear view of a plunger assembly wherein the gate is in the open position according to one embodiment of the document handling device of the present invention;

FIG. **13** is a rear view of a plunger assembly wherein the gate is in the closed position according to one embodiment of the document handling device of the present invention;

FIG. **14** is a perspective view of a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **15** is a rear view of a storage cassette according to one embodiment of the document handling device of the present invention;

FIG. **16** is a perspective view of a storage cassette where the door is open according to one embodiment of the document handling device of the present invention;

FIG. **17***a* is a top view of a storage cassette sized to accommodate United States currency documents according to one embodiment of the document handling device of the present invention;

FIG. **17***b* is a rear view of a storage cassette sized to accommodate United States currency documents according to one embodiment of the document handling device of the present invention;

FIG. **18***a* is a top view of a storage cassette sized to accommodate large documents according to one embodiment of the document handling device of the present invention;

FIG. **18***b* is a rear view of a storage cassette sized to accommodate large documents according to one embodiment of the document handling device of the present invention; and

FIG. **19** is a functional block diagram according to one embodiment of the document handling device of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring to FIGS. **1***a* and **1***b*, a multi-pocket document processing device **100** such as a currency handling device according to one embodiment of the present invention is illustrated. Currency bills are fed, one by one, from a stack of currency bills placed in an input receptacle **102** into a transport mechanism **104**. The transport mechanism **104** guides currency bills to one of a plurality of output receptacles **106***a*–**106***h*, which may include upper output receptacles **106***a*, **106***b*, as well as lower output receptacles **106***c*–**106***h*. Before reaching an output receptacle **106** the transport mechanism **104** guides the bill through an evaluation region **108** where a bill can be, for example, analyzed, authenticated, denominated, counted, and/or otherwise processed. In alternative embodiments of the currency handling device **100** of the present invention, the evaluation region **108** can determine bill orientation, bill size, or whether bills are stacked upon one another. The results of the above process or processes may be used to determine to which output receptacle **106** a bill is directed. The illustrated embodiment of the currency handling device has an overall width, W_1, of approximately 4.52 feet (1.38 meters), a height, H_1, of approximately 4.75 feet (1.45 meters), and a depth, D_1, of approximately 1.67 feet (0.50 meters).

In one embodiment, documents such as currency bills are transported, scanned, denominated, authenticated and/or otherwise processed at a rate equal to or greater than 600 bills per minute. In another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 800 bills per minute. In another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated and/or otherwise processed at a rate equal to or greater than 1000 bills per minute. In still another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 1200 bills per minute. In still another embodiment, documents such as currency bills are transported, scanned, denominated, authenticated, and/or otherwise processed at a rate equal to or greater than 1500 bills per minute.

In the illustrated embodiment, interposed in the bill transport mechanism **104**, intermediate the bill evaluation region **108** and the lower output receptacles **106***c*–**106***h* is a bill facing mechanism designated generally by reference numeral **110**. The bill facing mechanism is capable of rotating a bill 180° so that the face position of the bill is reversed. That is, if a U.S. bill, for example, is initially presented with the surface bearing a portrait of a president facing down, it may be directed to the facing mechanism **110**, whereupon it will be rotated 180° so that the surface with the portrait faces up. The leading edge of the bill remains constant while the bill is being rotated 180° by the facing mechanism **110**. The decision may be taken to send a bill to the facing mechanism **110** when the selected mode of operation or other operator instructions call for maintaining a given face position of bills as they are processed by the currency handling device **100**. For example, it may be desirable in certain circumstances for all of the bills ultimately delivered to the lower output receptacles **106***c*–**106***h* to have the bill surface bearing the portrait of the president facing up. In such embodiments of the currency handling device **100**, the bill evaluation region **108** is capable of determining the face position of a bill, such that a bill not having the desired face position can first be directed to the facing mechanism **110** before being delivered to the appropriate output receptacle **106**. Further details of a facing mechanism which may be utilized for this purpose are disclosed in commonly-owned, U.S. Pat. No. 6,047,334, incorporated herein by reference in its entirety, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and **1***b*. Alternatively, the facing mechanism disclosed in commonly-owned U.S. Pat. No. 6,371,303, entitled "Two Belt Bill Facing Mechanism" which was filed on Feb. 11, 2000, incorporated herein by reference in its entirety, may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and l*b*. Other alternative embodiments of the currency handling device **100** do not include the facing mechanism **110**.

The currency handling device **100** in FIG. **1***a* may be controlled from a separate controller or control unit **120** which has a display/user-interface **122**, which may incorporate a touch panel display in one embodiment of the present invention, which displays information, including "functional" keys when appropriate. The display/user-interface **122** may be a full graphics display. Alternatively, additional physical keys or buttons, such as a keyboard **124**, may be employed. The control unit **120** may be a self-contained desktop or laptop computer which communicates with the currency handling device **100** via a cable **125**. The currency handling device **100** may have a suitable communications port (not shown) for this purpose. In embodiments in which the control unit **120** is a desktop computer wherein the display/user-interface **122** and the desktop computer are physically separable, the desktop computer may be stored within a compartment **126** of the currency handling device **100**. In other alternative embodiments, the control unit **120** is integrated into the currency handling device **100** so the control unit **120** is contained within the device **100**.

The operator can control the operation of the currency handling device **100** through the control unit **120**. Through the control unit **120** the operator can direct the bills into specific output receptacles **106***a*–**106***h* by selecting various user defined modes. In alternative embodiments, the user can select pre-programmed user defined modes or create new user defined modes based on the particular requirements of the application. For example, the operator may select a user defined mode which instructs the currency handling device **100** to sort bills by denomination; accordingly, the evaluation region **108** would denominate the bills and direct one dollar bills into the first lower output receptacle **106***c*, five dollar bills into the second lower output receptacle **106***d*, ten dollar bills into the third lower output receptacle **106***e*, twenty dollar bills into the forth lower output receptacle **106***f*, fifty dollar bills into the fifth lower output receptacle **106***g*, and one-hundred dollar bills into the sixth lower output receptacle **106***h*. The operator may also instruct the currency handling device **100** to deliver those bills whose denomination was not determined, no call bills, to the first upper output receptacle **106***a*. In such an embodiment, upper output receptacle **106***a* would function as a reject pocket. In an alternative embodiment, the operator may instruct the currency handling device **100** to also evaluate the authenticity of each bill. In such an embodiment, authentic bills would be directed to the appropriate lower output receptacle **106***c*–**106***h*. Those bills that were determined not to be authentic, suspect bills, would be delivered to the second upper output receptacle **106***b*. A multitude of user defined modes are disclosed by U.S. Pat. No. 6,278,795 entitled "Multi-Pocket Currency Discriminator" which was filed on Aug. 21, 1997, incorporated herein by reference in its entirety, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and **1***b*.

According to one embodiment, the currency handling device **100** is designed so that when the evaluation region **108** is unable to identify certain criteria regarding a bill, the unidentified note is flagged and "presented" in one of the output receptacles **106***a*–**106***h*, that is, the transport mechanism **104** is stopped so that the unidentified bill is located at a predetermined position within one of the output receptacles **106***a*–**106***h*, such as being the last bill transported to one of the output receptacles. Such criteria can include denominating information, authenticating information, information indicative of the bill's series, or other information the evaluation region **108** is attempting to obtain pursuant to a mode of operation. Which output receptacles **106***a*–**106***h* the flagged bill is presented in may be determined by the user according to a selected mode of operation. For example, where the unidentified bill is the last bill transported to an output receptacle **106***a*–**106***h*, it may be positioned within a stacker wheel or positioned at the top of the bills already within the output receptacle **106***a*–**106***h*. While unidentified bills may be transported to any output receptacles **106***a*–**106***h*, it may be more convenient for the operator to have unidentified bills transported to one of the upper output receptacles **106***a,b* where the operator is able to easily see and/or inspect the bill which has not been identified by the evaluation region **108**. The operator may then either visually inspect the flagged bill while it is resting on the top of the stack, or alternatively, the operator may decide to remove the bill from the output receptacle **106** in order to examine the flagged bill more closely. In an alternative embodiment of the currency handling device **100**, the device **100** may communicate to the user via the display/user-interface **122** in which one of the output receptacles **106***a*–**106***h* a flagged bill is presented.

The currency handling device **100** may be designed to continue operation automatically when a flagged bill is removed from the upper output receptacle **106***a,b* or, according to one embodiment of the present invention, the device **100** may be designed to suspend operation and require input from the user via the control unit **120**. Upon examination of a flagged bill by the operator, it may be found that the

flagged bill is genuine even though it was not identified as so by the evaluation region **108** or the evaluation may have been unable to denominate the flagged bill. However, because the bill was not identified, the total value and/or denomination counters will not reflect its value. According to one embodiment, such an unidentified bill is removed from the output receptacles **106** and reprocessed or set aside. According to another embodiment, the flagged bills may accumulate in the upper output receptacles **106***a,b* until the batch of currency bills currently being processed is completed or the output receptacle **106***a,b* is full and then reprocessed or set aside.

According to another embodiment, when a bill is flagged, the transport mechanism may be stopped before the flagged bill is transported to one of the output receptacles. Such an embodiment is particularly suited for situations in which the operator need not examine the bill being flagged; for example, the currency handling device **100** is instructed to first process United States currency and then British currency pursuant to a selected mode of operation where the currency handling device **100** processes United States $1, $5, $10, $20, $50, and $100 currency bills into the lower output receptacles **106***c*–**106***h*, respectively. Upon detection of the first British pound note, the currency handling device **100** may halt operation allowing the operator to empty the lower output receptacles **106***c*–**106***h* and to make any spatial adjustments necessary to accommodate the British currency. A multitude of modes of operation are described in conjunction with bill flagging, presenting, and/or transport halting in commonly owned U.S. Pat. No. 6,278,795 entitled "Method and Apparatus for Document Processing" which was filed on May 28, 1997, incorporated herein by reference in its entirety above, which may be employed in conjunction with the present invention such as the device illustrated in FIGS. **1***a* and **1***b*.

In the illustrated embodiment, with regard to the upper output receptacles **106***a*, **106***b*, the second upper output receptacle **106***b* is provided with a stacker wheel **127** for accumulating a number of bills, while the first upper output receptacle **106***a* is not provided with such a stacker wheel. Thus, when pursuant to a preprogrammed mode of operation or an operator selected mode or other operator instructions, a bill is to be fed to the first upper output receptacle **106***a*, there may be a further instruction to momentarily suspend operation of the currency handling device **100** for the operator to inspect and remove the bill. On the other hand, it may be possible to allow a small number of bills to accumulate in the first upper output receptacle **106***a* prior to suspending operation. Similarly, the second upper output receptacle **106***b* may be utilized initially as an additional one of the lower output receptacles **106***c*–**106***h*. However, there is no storage cassette associated with the second upper output receptacle **106***b*. Therefore, when the second upper output receptacle **106***b* is full, operation may be suspended to remove the bills at such time as yet further bills are directed to the second upper output receptacle **106***b* in accordance with the selected mode of operation or other operator instructions. In an alternative embodiment of the currency handling device **100** both the first and the second upper output receptacles **106***a*–*b* are equipped with a stacker wheel. In such an embodiment both the upper output receptacles **106***a*–*b* may also function as the lower output receptacle **106***c*–**106***h* allowing a number of bills to be stacked therein, however, in the illustrated embodiment, there are no storage cassettes associated with the upper output receptacles **106***a*–*b*.

FIGS. **2***a* and **2***b* illustrate the evaluation region **108** according to one embodiment of the currency handling system **100**. The evaluation region can be opened for service, access to sensors, clear bill jams, etc. as shown in FIG. **2***a*. The characteristics of the evaluation region **108** may vary according to the particular application and needs of the user. The evaluation region **108** can accommodate a number and variety of different types of sensors depending on a number of variables. These variables are related to whether the machine is authenticating, counting, or discriminating denominations and what distinguishing characteristics are being examined, e.g. size, thickness, color, magnetism, reflectivity, absorbabilty, transmissivity, electrical conductivity, etc. The evaluation region **108** may employ a variety of detection means including, but not limited to, a size detection and density sensor **408**, a lower **410** and an upper **412** optical scan head, a single or multitude of magnetic sensors **414**, a thread sensor **416**, and an ultraviolet/fluorescent light scan head **418**. These detection means and a host of others are disclosed in commonly owned U.S. Pat. No. 6,278,795 entitled "Multi-Pocket Currency Discriminator," incorporated by reference above.

The direction of bill travel through the evaluation region **108** is indicated by arrow A. The bills are positively driven along a transport plate **400** through the evaluation region **108** by means of a transport roll arrangement comprising both driven rollers **402** and passive rollers **404**. The rollers **402** are driven by a motor (not shown) via a belt **401**. Passive rollers **404** are mounted in such a manner as to be freewheeling about their respective axis and biased into counter-rotating contact with the corresponding driven rollers **402**. The driven and passive rollers **402**, **404** are mounted so that they are substantially coplanar with the transport plate **400**. The transport roll arrangement also includes compressible rollers **406** to aid in maintaining the bills flat against the transport plate **400**. Maintaining the bill flat against the transport plate **400** so that the bill lies flat when transported past the sensors enhances the overall reliability of the evaluation processes. A similar transport arrangement is disclosed in commonly-owned U.S. Pat. No. 5,687,963 entitled "Method and Apparatus for Discriminating and Counting Documents," which is incorporated herein by reference in its entirety.

Referring now to FIGS. **3***a*–**3***d*, the input receptacle **102** of the currency handling device **100** is illustrated. A feeder mechanism such as a pair of stripping wheels **140** aid in feeding the bills in seriatim to the transport mechanism **104** which first carries the bills through the evaluation region **108**. According to one embodiment, the input receptacle **102** includes at least one spring-loaded feeder paddle **142***a* which is pivotally mounted, permitting it to be pivoted upward and drawn back to the rear of a stack of bills placed in the input receptacle **102** so as to bias the bills towards the evaluation region **108** via the pair of stripping wheels **140**. The paddle **142***a* is coupled to an advance mechanism **144** to urge the paddle **142***a* towards the stripping wheels **140**. In the illustrated embodiment, motion is imparted to the advance mechanism via a spring **145**. In other alternative embodiments, the advance mechanism **144** is motor driven. The advance mechanism **144** is slidably mounted to a shaft **146**. The advance mechanism **144** also constrains the paddle **142***a* to a linear path. The advance mechanism **144** may contain a liner bearing (not shown) allowing the paddle **142***a* to easily slide along the shaft **146**. In the embodiment illustrated, the paddle **142***a* may also contain channels **148** to aid in constraining the paddle **142***a* to a linear path along

a pair of tracks **150**. The paddle **142***a* may additionally include a roller **152** to facilitate the movement of the paddle **142***a*.

In the embodiment illustrated in FIGS. **3***a*–**3***d*, a second paddle **142***b* is provided such that a second stack of bills **147** may be placed in the input receptacle **102** behind a first group of bills **149**, while the first group of bills **149** is being fed into the currency handling device **100**. Thus, the two feeder paddles **142***a* and **142***b* may be alternated during processing in order to permit multiple stacks of currency bills to be loaded into the input receptacle **102**. In such an embodiment, the operator would retract paddle **142***a* and place a stack of bills into the input receptacle. Once inside the input receptacle, the operator would place the paddle **142***a* against the stack of bills so that the paddle **142***a* biases the stack of bills towards the pair of stripper wheels **140**. The operator could then load a second stack of bills into the input receptacle **102** by retracting the second paddle **142***b* and placing a stack of bills in the input receptacle between the paddles **142***a* and **142***b*. The second paddle **142***b* urges the second stack of bills up against the backside of the first paddle **142***a*. The operator can then upwardly rotate the first paddle **142***a* thus combining the two stacks. The first paddle **142***a* is then retracted to the rear of the input receptacle and the process can be repeated. The two paddle input receptacle allows the operator to more easily continuously feed stacks of bills to the currency handling device **100**. In devices not having two feeder paddles, the operator is forced to awkwardly manipulate the two stacks of bills and the advance mechanism. Alternatively, the operator may wait for the stack of bills to be processed out of the input receptacle to add another stack; however, waiting to reload until each stack is processed adds to the total time to process a given amount of currency.

Referring to FIG. **4**, a portion of the transport mechanism **104** and diverters **130***a*–**130***d* are illustrated. A substantial portion of the transport path of the currency handling device **100** positively grips the bills during transport from the pair of stripping wheels **140** through the point where bills are delivered to upper output receptacle **106***a* or are delivered to the stacker wheels **202** of output receptacles **106***b*–**106***h*. The positive grip transport path of the currency handling device **100** is less costly and weighs less than the vacuum transport arrangements of prior currency processing devices.

The transport mechanism **104** is electronically geared causing all sections to move synchronously from the evaluation region **108** through the point where the bills are delivered to the output receptacles **106**. Multiple small motors are used to drive the transport mechanism **104**. Using multiple small, less costly motors is more efficient and less costly than a single large motor. Further, less space is consumed enabling the currency handling device **100** to be more compact. Electronically gearing the transport mechanism **104** enables a single encoder to monitor bill transportation within the currency handling system **100**. The encoder is linked to the bill transport mechanism **104** and provides input to a processor to determine the timing of the operations of the currency handling device **100**. In this manner, the processor is able to monitor the precise location of the bills as they are transported through the currency handling device **100**. This process is termed "flow control." Input from additional sensors **119** located along the transport mechanism **104** of the currency handling device **100** enables the processor to continually update the position of a bill within the device **100** to accommodate for bill slippage. When a bill leaves the evaluation region **108** the processor expects the bill to arrive at the diverter **130***a* corresponding to the first lower output receptacle **106***c* after a precise number of encoder counts. Specifically, the processor expects the bill to flow past each sensor **119** positioned along the transport mechanism **104** at a precise number of encoder counts. If the bill slips during transport but passes a sensor **119** later within an acceptable number of encoder counts the processor updates or "re-queues" the new bill position. The processor calculates a new figure for the time the bill is expected to pass the next sensor **119** and arrive at the first diverter **130***a*. The processor activates the one of the diverters **130***a*–*f* to direct the bill into the appropriate corresponding lower output receptacle **106***c*–**106***h* when the sensor **119** immediately preceding the diverter **130** detects the passage of the bill to be directed into the appropriate lower output receptacle **106***c*–*h*.

The currency handling device **100** also uses flow control to detect bill jams within the transport mechanism **104** of the device **100**. When a bill does not reach a sensor **119** within in the calculated number of encoder counts plus the maximum number of counts allowable for slippage, the processor suspends operation of the device **100** and informs the operator via the display/user-interface **122** that a bill jam has occurred. The processor also notifies the operator via the display/user-interface **122** of the location of the bill jam by indicating the last sensor **119** that the bill passed and generally the approximate location of the bill jam in the system. If the operator cannot easily remove the bill without damage, the operator can then electronically jog the transport path in the forward or reverse direction via the control unit **120** so that the jammed bill is dislodged and the operator can easily remove the bill from the transport path. The operator can then flush the system causing the transport mechanism **104** to deliver all of the bills currently within the transport path of the currency handling device **100** to one of the output receptacles **106**. In an alternative embodiment, the user of the currency handling device **100** would have the option when flushing the system to first have the bills already within the escrow regions **116***a*–**116***f* to be delivered to the respective lower storage cassettes **106***c*–**106***h* so that those bills may be included in the aggregate value data for the bills being processed. The bills remaining in the transport path **104** would then be delivered to a predetermined escrow region **116** where those bills could be removed and reprocessed by placing those bills in the input receptacle **102**.

Utilizing flow control to detect bill jams is more desirable than prior art currency evaluation machines which do not detect a bill jam until a sensor is actually physically blocked. The latter method of bill jam detection permits bills to pile up while waiting for a sensor to become blocked. Bill pile-up is problematic because it may physically halt the machine before the bill jam is detected and may cause physical damage to the bills and the machine. In order to remedy a bill jam in a prior art machine, the operator must first manually physically dislodge the jammed bills. The operator must then manually turn a hand crank which advances the transport path until all bills within the transport path are removed. Moreover, because the prior art devices permit multiple bills to pile up before a bill jam is detected, the integrity of the process is often ruined. In such a case, the entire stack of bills must be reprocessed.

Referring back to FIG. **1***a*, the illustrated embodiment of the currency handling device **100** includes a total of six lower output receptacles **106***c*–**106***h*. More specifically, each of the lower output receptacles **106***c*–**106***h* includes a first portion designated as an escrow compartment **116***a*–**116***f* and a second portion designated as a storage cassette

118*a*–118*f* Typically, bills are initially directed to the escrow compartments **116**, and thereafter at specified times or upon the occurrence of specified events, which may be selected or programmed by an operator, bills are then fed to the storage cassettes **118**. The storage cassettes are removable and replaceable, such that stacks of bills totaling a predetermined number of bills or a predetermined monetary value may be accumulated in a given storage cassette **118**, whereupon the cassette may be removed and replaced with an empty storage cassette. In the illustrated embodiment, the number of lower output receptacles **106***c*–**106***h* including escrow compartments **116** and storage cassettes **118** are six in number. In alternative embodiments, the currency handling device **100** may contain more or less than six lower output receptacles including escrow compartments and storage cassettes **118**. In other alternative embodiments, modular lower output receptacles **106** can be implemented to add many more lower output receptacles to the currency handling system **100**. Each modular unit may comprise two lower output receptacles. In other alternative embodiments, several modular units may be added at one time to the currency handling device **100**.

A series of diverters **130***a*–**130***f*, which are a part of the transportation mechanism **104**, direct the bills to one of the lower output receptacles **106***c*–**106***h*. When the diverters **130** are in an upper position, the bills are directed to the adjacent lower output receptacle **106**. When the diverters **130** are in a lower position, the bills proceed in the direction of the next diverter **130**.

The vertical arrangement of the lower output receptacles **106***c*–**106***h* is illustrated in FIG. **5**. The escrow compartment **116** is positioned above the storage cassette **118**. In addition to the escrow compartment **116** and the storage cassette **118**, each of the lower output receptacles **106***c*–**106***h* contains a plunger assembly **300**. The plunger assembly **300** is shown during its decent towards the storage cassette **118**.

Referring now to FIGS. **6** and **7**, one of the escrow compartments **116** of the lower output receptacles **106***c*–**106***h* is shown. The escrow compartment **116** contains a stacker wheel **202** to receive the bills **204** from the diverter **130**. The stacker wheel **202** stacks the bills **204** within the escrow compartment walls **206**, **208** on top of a gate **210** disposed between the escrow compartment **116** and the storage cassette **118**. In an alternative embodiment, the escrow compartment **116** contains a pair of guides to aid in aligning the bills substantially directly on top of one another. The gate **210** is made up of two shutters: a first shutter **211** and a second shutter **212**. The shutters **211**, **212** are hingedly connected enabling the shutters **211**, **212** to rotate downward approximately ninety degrees to move the gate from a first position (closed position) wherein the shutters **211**, **212** are substantially co-planer to a second position (open position) wherein the shutters **211**, **212** are substantially parallel. Below the gate **210** is the storage cassette **118** (not shown in FIGS. **6** and **7**).

FIG. **8** illustrates the positioning of the paddle **302** when transferring a stack of bills from the escrow compartment **116** to the storage cassette **118**. When the paddle descends upon the stack of bills **204** it causes shutters **211**, **212** to quickly rotate in the directions referred to by arrows B and C, respectively; thus, "snapping" open the gate **210**. The quick rotation of the shutters **211**, **212** insures that the bills fall into the storage cassette **118** in a substantially stacked position. According to one embodiment, the paddle is programmed to descend after a predetermined number of bills **204** are stacked upon the gate **210**. According to other embodiments, the operator can instruct the paddle **302** via the control unit **120** to descend upon the bills **204** stacked upon the gate **210**.

Referring now to FIG. **9**, the plunger assembly **300** for selectively transferring the bills **204** from an escrow compartment **116** to a corresponding storage cassette **118** and the gate **210** are illustrated in more detail. One such plunger assembly **300** is provided for each of the six lower output receptacles **106***c*–**106***h* of the currency handling device **100**. The plunger assembly **300** comprises a paddle **302**, a base **304**, and two side arms **306**, **308**. Each of the shutters **211**, **212** comprising the gate **210** extend inwardly from corresponding parallel bars **214**, **215**. The bars **214**, **215** are mounted for pivoting the shutters between the closed position and the open position. Levers **216**, **217** are coupled to the parallel bars **214**, **215**, respectively, to control the rotation of the bars **214**, **215** and hence of the shutters **211**, **212**. Extension springs **218**, **219** (shown in FIG. **8**) tend to maintain the position of the levers **216**, **217** both in the closed and open positions. The shutters **211**, **212** have an integral tongue **213***a* and groove **213***b* arrangement which prevents any bills which are stacked upon the gate **210** from slipping between the shutters **211**, **212**.

The base **304** travels along a vertical shaft **311** with which it is slidably engaged. The base **304** may include linear bearings (not shown) to facilitate its movement along the vertical shaft **311**. The plunger assembly **300** may also include a vertical guiding member **312** (see FIG. **11**) with which the base **304** is also slidably engaged. The vertical guiding member **312** maintains the alignment of the plunger assembly **300** by preventing the plunger assembly **300** from twisting laterally about the vertical shaft **311** when the paddle **302** forces the bills **204** stacked in the escrow area **116** down into a storage cassette **118**.

Referring also to FIG. **10**, the paddle **302** extends laterally from the base **304**. The paddle **302** is secured to a support **314** extending from the base **304**. A pair of side arms **306**, **308** are hingedly connected to the base. Each of the side arms **306**, **308** protrude from the sides of the base **304**. Rollers **316**, **318** are attached to the side arms **306**, **308**, respectively, and are free rolling. Springs **313***a*, **313***b* are attached to the side arms **306**, **308**, respectively, to bias the side arms **306**, **308** outward from the base **304**. In the illustrated embodiment, the spring **313***a*, **313***b* are compression springs.

The paddle **302** contains a first pair of slots **324** to allow the paddle to clear the stacker wheel **202** when descending into and ascending out of the cassette **118**. The first pair of slots **324** also enables the paddle **302** to clear the first pair of retaining tabs **350** within the storage cassette (see FIG. **14**). Similarly, paddle **302** contains a second pair of slots **326** to enable the paddle **302** to clear the second pair of retaining tabs **350** within the storage cassette **118** (see FIG. **14**).

Referring now to FIG. **11**, which illustrates a rear view of one of the lower output receptacles **106***c*–**106***h*, the plunger **300** is bidirectionally driven by way of a belt **328** coupled to an electric motor **330**. A clamp **332** engages the belt **328** into a channel **334** in the base **304** of the plunger assembly **300**. In the embodiment illustrated in FIG. **11**, two plunger assemblies **300** are driven by a single electric motor **330**. In one embodiment of the currency handling device, the belt **328** is a timing belt. In other alternative embodiments, each plunger assembly **300** can be driven by a single electric motor **330**. In still other alternative embodiments, there can be any combination of motors **330** to plunger assemblies **300**.

FIGS. **12** and **13** illustrate the interaction between the side arms **306**, **308** and the levers **216**, **217** when the paddle assembly **300** is descending towards and ascending away from the storage cassette **118**, respectively. Initially, before descending towards the cassette, the shutters are in a first (closed) position. In the illustrated embodiment, it is the force imparted by the paddle **302** which opens the gate **210** when the paddle descends towards the storage cassette **118**. When the paddle is ascending away from the storage cassette **119**, it is the rollers **316**, **318** coupled to the side arms **306**, **308** which engage the levers **216**, **217** that close the gate **210**. The levers **216**, **217** shown in FIG. **12** are positioned in the open position. When descending towards the storage cassette **118**, the rollers **316**, **318** contact the levers **216**, **217** and roll around the levers **216**, **217** leaving the shutters in the open position. The side arms **306**, **308** are hinged in a manner which allows the side arms **306**, **308** to rotate inward towards the base **304** as the rollers **316**, **318** engage the levers **216**, **217**. FIG. **13** illustrates the levers in the second position wherein the gate **210** is closed. When the paddle ascends out of the storage cassette, the side arms **306**, **308** are biased away from the base **304**. The rollers **316**, **318** engage the levers **216**, **217** causing the levers to rotate upward to the first position thus closing the gate.

FIGS. **14**, **15**, and **16** illustrate the components of the storage cassettes **118**. The bills **204** are stored within the cassette housing **348** which has a base **349**. Each storage cassette **118** contains two pairs of retaining tabs **350** positioned adjacent to the interior walls **351**, **352** of the storage cassette. The lower surface **354** of each tab **350** is substantially planar. The tabs **350** are hingedly connected to the storage cassette **118** enabling the tabs **350** to downwardly rotate from a horizontal position, substantially perpendicular with the side interior walls **351**, **352** of the cassette **118**, to a vertical position, substantially parallel to the interior walls **351**, **352** of the cassette **118**. The tabs **350** are coupled to springs (not shown) to maintain the tabs in the horizontal position.

The storage cassette **118** contains a slidable platform **356** which is biased upward. During operation of the currency handling system **100**, the platform **356** receives stacks of bills from the escrow compartment **116**. The floor **356** is attached to a base **358** which is slidably mounted to a vertical support member **360**. The base **358** is spring-loaded so that it is biased upward and in turn biases the platform **356** upward. The storage cassettes **118** are designed to be interchangeable so that once full, a storage cassette can be easily removed from the currency handling device **100** and replaced with an empty storage cassette **118**. In the illustrated embodiment, the storage cassette **118** is equipped with a handle **357** in order to expedite removal and/or replacement of the storage cassettes **118**. Also in the illustrated embodiment, the storage cassette **118** has a door **359** which enables an operator to remove bills from the storage cassette **118**

The storage cassettes **118** are dimensioned to accommodate documents of varying sizes. In the illustrated embodiment, the storage cassettes **118** has a height, H_2, of approximately 15.38 inches (39 cm), a depth, D_2, of approximately 9 inches (22.9 cm), and a width, W_2, of approximately 5.66 inches (14.4 cm). The storage cassette illustrated in FIG. **15** has stand-offs **362** to set interior wall **352** off a fixed distance from in the interior wall **353** of the cassette housing **348**. The interior walls **351**, **352** aid in aligning the bills in a stack within the storage cassettes. The embodiment of the storage cassette illustrated in FIG. **15** is sized to accommodate United States currency documents. To properly accommodate United States currency documents, the interior width of the storage cassette, W_3, is approximately 2.88 inches. FIGS. **17***a* and **17***b* also illustrate an embodiment of the storage cassette **118** sized to accommodate U.S. currency documents which have a width of approximately 2.5 inches (approximately 6.5 cm) and a length of approximately 6 inches (approximately 15.5 cm). In alternative embodiments, the length of the stand-offs **362** can be varied to accommodate documents of varying sizes. For example, the embodiment disclosed in FIGS. **18***a* and **18***b* has an interior width, W_3 of approximately 4.12 inches (104.6 cm) and is sized to accommodate the largest international currency, the French 500 Franc note, which has width of approximately 3.82 inches (9.7 cm) and a length of approximately 7.17 inches (18.2 cm). In order to accommodate large documents and increase the interior width, W_3, of the storage cassette **118**, the lengths of stand-offs **362**, illustrated in FIG. **16***b*, are shortened.

Beginning with FIG. **7**, the operation of one of the lower output receptacles **106***c*–**106***h* will be described. Pursuant to a mode of operation, the bills **204** are directed by one of the diverters **130** into the escrow compartment **116** of the lower output receptacle. The stacker wheel **202** within escrow compartment **116** receives the bills **204** from the diverter **130**. The stacker wheel **202** stacks the bills **204** on top of the gate **210**. Pursuant to a preprogrammed mode of operation, once a predetermined number of bills **204** are stacked in the escrow compartment **116**, the control unit **120** instructs the currency handling device **100** to suspend processing currency bills and the paddle **302** then descends from its home position above the escrow compartment **116** to transfer the bills **204** into the storage cassette **118**. Once the bills **204** have been deposited in the storage cassette **118** the currency handling device resumes operation until an escrow compartment is full or all the bills within the input receptacle **102** have been processed.

Referring now to FIGS. **8** and **9** the plunger assembly **300** downwardly travels placing the paddle **302** onto of the stack of bills **204**. Upon making contact with the bills **204** the paddle **302** continues to travel downward. As the paddle **302** continues its descent, the paddle **302** forces the gate **210** to snap open. The paddle **302** imparts a force to the bills **204** that is transferred to the to the shutters **211**, **212** causing the shutters **211**, **212** to rotate from the closed position to the open position. The rotation of the shutters **211**, **212** is indicated by the arrows B and C, respectively. Once the paddle **302** imparts the amount of force necessary to rotate levers **216**, **217**, the extension springs **218**, **219** quickly rotate the shutters **211**, **212** downward, thus "snapping" the gate **210** open. The downward rotation of the shutters **211**, **212** causes each of the corresponding parallel bars **214**, **215** to pivot which in turn rotates the levers **216**, **217**. The extension springs **218**, **219** maintain the shutters **211**, **212** in the open position allowing the paddle **302** to descend into the storage cassette **118**. The hingedly connected side arms **306**, **308** retract as the rollers **316**, **318** to roll around the levers **216**, **217** while the plunger assembly **300** is traveling downward into the cassette **118**.

Referring now to FIG. **15**, once the gate **210** is opened, the bills **204** fall a short distance onto the platform **356** of the storage cassette **118** or onto a stack of bills **204** already deposited on the platform **356**. The paddle **302** continues its downward motion towards the storage cassette **118** to ensure that the bills **204** are transferred to the cassette **118**. Initially, some bills **204** may be spaced apart from the platform **356** or the other bills **204** within the storage cassette by retaining tabs **350**. As the plunger assembly **300** continues to descend

downward into the cassette, the paddle **302** continues to urge the stack of bills **204** downward causing the retaining tabs **350** to rotate downward. The bills **204** are pushed past retaining tabs **350** and onto the platform **356**.

Once the plunger assembly **300** has descended into the cassette **118** a distance sufficient for the paddle **302** to clear the retaining tabs **350** allowing the retaining tabs **350** to rotate upward, the plunger assembly initiates its ascent out of the storage cassette **118**. The platform **356** urges the bills **204** upward against the underside of the paddle **302**. The paddle **302** is equipped with two pairs of slots **324**, **326** (FIG. **9**) to enable the paddle to clear the pairs of retaining tabs **350**. When the paddle **302** ascends past the pairs of retaining tabs **350** the bills **204** are pressed against the lower surfaces **354** of the pairs of retaining tabs **350** by the platform **356**.

Referring now to FIG. **13**, when the plunger assembly **300** is traveling upward out of the cassette **118**, the rollers **316**, **318** on the side arms **306**, **308** engage the respective levers **216**, **217** and move the respective levers **216**, **217** from the second (open) position to the first (closed) position to move the gate **210** from the open position to the closed position as the paddle **302** ascends into the escrow compartment **116** after depositing the bills **204** in the storage cassette **118**. The paddle **302** is mounted on the base **304** above the rollers **316**, **318** on the side arms **306**, **308** so that the paddle **302** clears the gate **210** before the gate **210** is moved to the closed position.

In alternative embodiments of the currency handling device **100**, the output receptacles **106** can be sized to accommodate documents of varying sizes such as various international currencies, stock certificates, postage stamps, store coupons, etc. Specifically, to accommodate documents of different widths, the width of the escrow compartment **116**, the gate **210**, and the storage cassette **118** would need to be increased or decreased as appropriate. The document evaluation device **100** is sized to accommodate storage cassettes **118** and gates **210** of different widths. The entire transport mechanism **104** of the currency handling device **100** is dimensioned to accommodate the largest currency bills internationally. Accordingly, the document handling device **100** can be used to process the currency or documents of varying sizes.

In various alternative embodiments, the currency handling device **100** is dimensioned to process a stack of different sized currencies at the same time. For example, one application may require the processing of United States dollars (2.5 inches×6 inches, 6.5 cm×15.5 cm) and French currency (as large as 7.17 inches×3.82 inches, 18.2 cm×9.7 cm). The application may simply require the segregation of the U.S. currency from the French currency wherein the currency handling device **100** delivers U.S. currency to the first lower output receptacle **106***c* and the French currency to the second output receptacle **106***d*. In another alternative embodiment, the currency handling device **100** processes a mixed stack of U.S. ten and twenty dollar bills and French one hundred and two hundred Franc notes wherein the currency documents are denominated, counted, and authenticated. In that alternative embodiment, the U.S. ten and twenty dollar bills are delivered to the first **106***c* and second **106***d* lower output receptacles, respectively, and the French one hundred and two hundred Franc notes are delivered to the third **106***e* and fourth **106***f* lower output receptacle, respectively. In other alternative embodiments, the currency handling device **100** denominates, counts, and authenticates six different types of currency wherein, for example, Canadian currency is delivered to the first lower output receptacle **106***c*, United States currency is delivered to the second output receptacle **106***d*, Japanese currency is delivered to the third lower output receptacle **106***e*, British currency is delivered to the fourth lower output receptacle **106***f*, French currency is delivered to the fifth lower output receptacle **106***g*, and German currency is delivered to the sixth lower output receptacle **106***h*. In another embodiment, no call bills or other denominations of currency, such as Mexican currency for example, may be directed to the second upper output receptacle **106***b*. In another embodiment, suspect bills are delivered to the first upper output receptacle **106***a*.

In other alternative embodiments of the currency handling device **100**, the user can vary the type of documents delivered to the output receptacles **106**. For example, in one alternative embodiment an operator can direct, via the control unit **120**, that a stack of one, five, ten, twenty, fifty, and one-hundred United States dollar bills be denominated, counted, authenticated, and directed into lower output receptacles **106***c*–**106***h*, respectively. In still another alternative embodiment, the currency handling device **100** is also instructed to deliver other bills, such as a United States two dollar bill or currency documents from other countries that have been mixed into the stack of bills, to the second upper output receptacle **106***b*. In still another alternative embodiment, the currency handling device **100** is also instructed to count the number and aggregate value of all the currency bills processed and the number and aggravate value of each individual denomination of currency bills processed. These values can be communicated to the user via the display/user-interface **122** of the currency handling device **100**. In still another alternative embodiment, no call bills and bills that are stacked upon one another are directed to the second upper output receptacle **106***b*. In still another alternative embodiment, the operator can direct that all documents failing an authentication test be delivered to the first upper output receptacle **106***a*. In another alternative embodiment, the operator instructs the currency handling device **100** to deliver no call bills, suspect bills, stacked bills, etc. to one of the lower output receptacles **106***c*–**106***h*. The currency handling device **100** which has eight output receptacles **106***a*–**106***h* provides a great deal of flexibility to the user. And in other alternative embodiments of the currency handling device **100**, numerous different combinations for processing documents are available.

According to one embodiment, the various operations of the currency handling device **100** are controlled by processors disposed on a number of printed circuit boards ("PCBs") such as ten PCBs located throughout the device **100**. In one embodiment of the present invention, the processors are Motorola processors, model number 86HC16, manufactured by Motorola, Inc. of Schaumburg, Ill. Each of the processors are linked to a central controller via a general purpose communications controller disposed on each PCB. In one embodiment of the present invention the communications controller is an ARCNET communications controller, model COM20020, manufactured by Standard Microsystems Corporation of Hauppauge, N.Y. The communications controller enables the central controller to quickly and efficiently communicate with the various components linked to the PCBs.

According to one embodiment, two PCBs, a "motor board" and a "sensor board," are associated with each pair of lower output receptacles **106***c*–**106***h*. The first two lower output receptacles **106***c,d*, the second two lower output receptacles **106***e,f*, and the last two lower output receptacles **106***g,h* are paired together. Each of the lower output receptacles **106** contain sensors which track the movement of the

bills into the lower output receptacles **106***c*–**106***h*, detect whether each storage cassette **118***a*–**118***e* is positioned within the currency handling device **100**, detect whether the doors **359** of the storage cassettes **118** are opened or closed, and whether the cassettes **118** are full. These aforementioned sensors associated with each pair of the lower output receptacles are tied into a sensor board which is linked to the central controller. The operation of the plunger assembly **300**, the stacker wheels **202**, the portion of transportation mechanism **104** disposed above the lower output receptacles **116***c*–**116***h*, and the diverters **130** are controlled by processors disposed on the motor board associated with each pair of lower output receptacle's **106***c*–**106***h*. Those sensors **130** which track the movement of bills along the transportation mechanism **104** that are disposed directly above the lower output receptacles **106***c*–**106***h* are also tied into the respective motor boards.

One of the four remaining PCBs is associated with the operation of the one or two stacker wheels **127** associated with the upper output receptacles **106***a,b*, the stripping wheels **140**, the primary drive motor of the evaluation region **108**, a diverter which direct bills to the two upper output receptacles **106***a,b*, and the diverter which then directs bills between the two upper output receptacles **106***a,b*. The remaining three PCBs are associated with the operation of the transport mechanism **104** and a diverter which directs bills from the transport path to the bill facing mechanism **110**. The plurality of sensors **130** disposed along the transport mechanism **104**, used to track the movement of bills along the transport mechanism **104**, also tied into these three remaining PCBs.

As discussed above, the currency handling system utilizes flow control to track the movement of each individual bill through the currency handling device **100** as well as to detect the occurrence of bill jams within the currency handling device **100**. Utilizing flow control not only allows the device **100** to more quickly detect bill jams, but also enables the device **100** to implement a bill jam reconciliation procedure which results in a significant time savings over the prior art. During normal operation, a processor in conjunction with the plurality of sensors **119** disposed along the transport mechanism **104** tracks each of the currency bills transported through the currency handling device **100** from the evaluation region **108** to the escrow regions **116**. Accordingly, the processor monitors the number of bills that have, for example, advanced from the input receptacle **102** through the evaluation unit **108**, the number of bills stacked in each of the escrow regions **116***a–f*, and the number of bills moved into the storage cassettes **118***a–f*. The device **100** maintains separate counts of the number of bills delivered into each escrow region **116** and each of the storage cassettes **118**. As bills are moved from an escrow region **116** to a corresponding storage cassette **118** the total number of bills being moved is added to the total number of bills in the storage cassette **118**.

Upon the detection of a bill jam occurring in the transport mechanism **104**, the processor has maintained an accurate count of the number of bills which have already been transported into each escrow region **116**. The integrity of the bill count is maintained because the flow control routine rapidly determines the presence of a bill jam within the transport mechanism **104**. Again, as discussed above, if a bill does not pass the next sensor **119** within a predetermined number of encoder counts, the operation of the transportation mechanism **104** is suspended and the user is alerted of the error. Because the transporting of bills is suspended almost immediately upon failure of a bill to pass a sensor **119** within a specific timeframe (e.g. number of encoder counts) thus preventing the pile-up of bills, the processor "knows" the specific location of each of the bills within the device **100** because the operation of the device is suspended before bills are allowed to pile up.

Because of the almost immediate suspension of the transporting of bills, the integrity of the counts of the bills in the escrow regions **116** and the storage cassettes **118** are maintained. Before the system is flushed, the bills within each of the escrow regions **116** are downwardly transported from the escrow regions **116** to the corresponding storage cassettes **118**. If the bill jam occurs in one of the escrow regions **116**, bills located in other escrow regions **116** where the bill jam has not occurred are transported to the respective storage cassettes **118**.

In one embodiment of the currency evaluation device **10**, the user is notified via the user interface **122** of the occurrence of a bill jam and the suspension of the transporting of bills. The user is prompted as to whether the bills in the escrow regions **116** should be moved to the storage cassettes **118**. In other embodiments of the currency handling device, those bills already in the escrow regions are automatically moved to the storage cassettes upon detection of a bill jam. The user is directed, via the user interface **122**, to the proximate location of the bill jam in the transport mechanism **104**. If necessary, the user can electronically jog the transport mechanism **104**, as described above, to facilitate the manual removal of the bill jam. After clearing the bill jam and causing those bill already transported into the escrow regions **116** to be moved into the corresponding storage cassettes **118**, the user is prompted to flush the bills currently within the transport mechanism **104**. Flushing the bills causes those bills still remaining in the transport mechanism **104** to be transported to one of the escrow regions **116**. After the remaining bills are flushed from the transport mechanism **116**, the operator can remove the flushed bills from the escrow region **116** for reprocessing.

Referring now to FIG. **19**, the operation of the bill jam reconciliation process will be described in connection with the illustrated functional block diagram of the currency handling device **100**. Pursuant to the user's selected mode of operation, currency bills are transported from the input receptacle **102** though the evaluation region **108** to one of the plurality of output receptacles **106***a–h*. According to some modes of operation, some of the currency bills all also transported through the bill facing mechanism **110** in those embodiments of the currency handling device **100** which implementing a bill facing mechanism **110**. As each of the bills are transported thorough the currency handling device **100** by the transport mechanism **104**, a processor, in connection with the plurality of bill passage sensors **119**, tracks the movement of each of the bills from the evaluation region **106** to each of the escrow regions **116***a–f* pursuant to the flow control process discussed above. As bills are delivered into each of the escrow regions **116***a–f*, a escrow region bill counter **202** ("ER Count" in FIG. **19**) assigned to each escrow region **116** maintains a count of the number of bills transported into each escrow region **116**. After a predetermined number of bills have been transported into an escrow region **116**, the operation of the transport mechanism is temporarily suspended while the bills are moved from the escrow region **116** to the corresponding storage cassette **118**. A storage cassette counter **204** ("SC Count" in FIG. **19**) corresponding to each storage cassette **118**, maintains a count of the total number of bills moved into a storage cassette. Upon moving bills from the escrow region **116** to the corresponding storage cassette **118**, the escrow region

count is added to the storage cassette count. After the adding the escrow region count and the storage cassette count, the escrow region counter **202** is reset to zero and the operation of the transport mechanism is resumed.

Upon detection of the occurrence of a bill jam, the operation of the transport mechanism **104** is suspended. At the time of the occurrence of a bill jam, each of the escrow regions have as many as two hundred fifty bills or as little as zero bills transported therein. A count of the specific number of bills in each of the escrow regions **116***a–f* is maintained by each of the escrow region counters **202***a–f*. In response to user input, the bills within the escrow regions **116** are moved from the escrow regions **116** to the storage cassettes **118** and the escrow bill count **202** is added to the storage cassette bill count **204**. The operator of the currency handling device **100** can then clear the bill jam and flush the remaining bill from the transport mechanism **104** as discussed above. If the bill jam has occurred in one of the escrow regions **116**, the bills in the remaining escrow regions **116** not having bill jams detected therein are moved to the corresponding storage cassettes **118**. Those bill already transported into the escrow region **116** having the bill jam detected therein are reprocessed along with the bills flushed from the transport mechanism **104**.

The ability of the currency handling device **100** to transport those bills already processed into the escrow regions **116** and into the storage cassettes **118** while maintaining the integrity of the bill counts **202**,**204** with respect to each output receptacle **106***c–h* is a significant improvement resulting in appreciable time savings over prior art devices. In prior art devices, upon the occurrence of a bill jam, the operator would have to clear the bill jam and manually turn a hand crank to move the remaining bills from the transport path into the escrowing regions. Prior art devices do not maintain separate running totals as bills pass various points within the device. For example, a prior device may only count the bills as they are transported through an evaluation region of the currency handing machine. Bills exiting the evaluation region are included in the totals regardless of whether they are involved in bill jams or are successfully transported to an output receptacle. Therefore, when a bill jam occurs, those bills involved in the bill jam as well as those bills already transported to the output receptacles have to be reprocessed. Other prior art devices having both holding areas and storage areas only maintain a count of the number of bill in the storage areas, but not a count of the number of bills in the holding areas.

Reprocessing all of the bills already transported into the holding areas is a time consuming process as the number of bills to be re-processed can be voluminous. In the present device for example, each of the escrow regions **116** can accommodate approximately 250 bills. Six escrow regions presents the possibility of having to reprocess up to 1500 bills upon the occurrence of a bill jam. The problem is further exasperated when modular lower output receptacles **106** are added. For example, the addition of eight modular lower output receptacles **106** brings the total number of lower output receptacles **106** to fourteen, thus up to 3500 bills would have to be reprocessed. The inefficiencies associated with this procedure arise from the loss of productivity while the device **100** is stopped and the time required to remove the stacks of bills from the escrow regions **116** as well as the time required to re-process the bills pulled from the escrow regions **116**.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and herein described in detail. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for processing currency bills with a currency handling device, the method comprising the device performing the acts of:

receiving a stack of a plurality of bills in an input receptacle;

transporting the bills with a transport mechanism, one at a time, from the input receptacle along a transport path into a plurality of output receptacles, at least one of the plurality of the output receptacles including a holding area and a corresponding storage area;

determining information concerning the bills with an evaluating unit at a rate of at least 800 bills per minute;

maintaining a count of the total number of bills transported into the holding area;

moving the bills transported into the holding area into the corresponding storage area after a predetermined number of bills have been stacked in the holding area;

maintaining a count of the total number of bills moved into the storage area;

tracking the movement of each of the bills along the transport path with a plurality of bill passage sensors, each of the plurality of sensors being adapted to detect the passage of a bill as each bill is transported past each sensor;

detecting the presence of a bill jam when a bill is not transported past one of the plurality of bill passage sensors along the transport path within a predetermined amount of time; and

suspending operation of the transport mechanism upon detection of a bill jam.

2. The method of claim **1** further comprising the act of moving the bills already transported into the holding area to the corresponding storage area upon suspension of the operation of the transport mechanism.

3. The method of claim **2** further comprising the act of updating the count of the number of bills moved into the storage area by adding thereto the count of the number of bills transported into the corresponding holding area prior to moving the bills from the holding area to the corresponding storage area upon suspension of the operation of the transport mechanism.

4. The method of claim **3** further comprising the act of resetting the count of the total number of bills transported into the holding area.

5. The method of claim **2** further comprising the act of receiving input from a user of the currency handling device via a user interface, the input including operational instructions, and wherein the act of moving the bills already transported into the holding area to the corresponding storage area further comprises the act of moving the bills already transported into the holding area to the corresponding storage area after suspension of the operation of the transport mechanism in response to user input.

6. The method of claim **2** further comprising the act of flushing the bills from the transport path after the act of moving the bills already transported into the holding area to the corresponding storage area.

7. The method of claim **6** further comprising the acts of receiving input from a user of the currency handling device via a user interface, the input including operational instruc-

tions, and wherein flushing the bills further comprises the act of flushing the bills in response to user input.

8. The method of claim **2** wherein a plurality of the plurality of output receptacles include a holding area and a corresponding storage area, the method further comprising the acts of detecting the presence of a bill jam in one of the holding areas when a bill is not transported past a predetermined position within the holding area within a predetermined amount of time, and wherein the act of moving the bills already transported into each of the other holding areas further comprises the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein to the corresponding storage areas upon suspension of the operation of the transport mechanism.

9. The method of claim **8** further comprising the act of receiving input from a user of the device via a user interface, the input including operational instructions, and wherein the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein further comprises the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein to the corresponding storage areas upon suspension of the operation of the transport mechanism in response to user input.

10. The method of claim **9** further comprises the act of flushing the bills from the transport path after moving the bills already transported into the holding areas not having a bill jam detected therein upon suspension of the operation of the transport mechanism in response to user input.

11. The method of claim **9** wherein the act of determining information further comprises the act of determining information concerning the bills with an evaluating unit at a rate of at least about 1500 bills per minute.

12. The method of claim **9** further comprising the acts of:

reversing the face orientation of a bill with a bill facing mechanism where the face orientation of a bill does not match a target orientation and;

detecting the presence of a bill jam in the bill facing mechanism when a bill is not transported past one of a plurality of bill passage sensors disposed along a transport path of the bill facing mechanism within a requisite number of encoder counts.

13. The method of claim **9** further comprising the act of stacking the bills in each of the holding areas.

14. The method of claim **9** further comprising the act of generating an encoder count for each incremental movement of the transport mechanism.

15. The method of claim **14** further comprising the act of detecting the presence of a bill jam when a bill is not transported past one of the plurality of bill passage sensors within a requisite number of encoder counts.

16. A method of handling bill jams within a currency processing device, the device including a transport mechanism including an encoder adapted to transport bills along a transport path, one at a time, from an input receptacle past an evaluation unit into a plurality of output receptacles, at least two of the plurality of the output receptacles each including a holding area and a storage area, the device having a plurality of bill passage sensors sequentially disposed along the transport path adapted to detect the passage of a bill as each bill is transported past each sensor, the method comprising the acts of:

maintaining a separate count for each of the holding areas of the number of bills transported into each of the holding areas;

moving the bills from a holding area to a corresponding storage area after a predetermined number of bills have been transported into the holding area;

maintaining a separate count for each of the storage areas of the number of bills moved into each of the storage areas;

tracking the movement of each of the bills along the transport path into each of the holding areas with the plurality of bill passage sensors;

generating an encoder count for each incremental movement of the transport mechanism;

detecting the presence of a bill jam when a bill is not transported past one of the plurality of bill passage sensors within a requisite number of encoder counts;

suspending operation of the transport mechanism upon detection of a bill jam;

moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism;

for each of the storage areas, updating the count of the number of bills moved into each of the storage areas by adding thereto the count of the number of bills transported into the corresponding holding areas prior to moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism; and

resetting the count of the total number of bills transported into each of the holding areas.

17. The method of claim **16** further comprising the act of electronically jogging the transport mechanism.

18. The method of claim **17** further comprising the act of flushing the bills from the transport path after moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism.

19. The method of claim **17** further comprising the act of manually clearing the bill jam from the transport path.

20. The method of claim **19** further comprising the act of flushing the bills from the transport path after moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism.

21. The method of claim **16** further comprising the act of manually clearing the bill jam from the transport path.

22. The method of claim **21** further comprising the act of flushing the bills from the transport path after moving the bills from each of the holding areas to the corresponding storage areas upon suspension of the operation of the transport mechanism.

23. The method of claim **16** further comprising the act of receiving input from a user of the device via a user interface, the input including operational instructions, and wherein the act of moving the bills already transported into each of the holding areas to the corresponding storage areas further comprises the act of moving the bills already transported into each of the holding areas to the corresponding storage areas after suspension of the operation of the transport mechanism in response to user input.

24. The method of claim **23** wherein the act of flushing the bills further comprises the act of flushing the bills from the transport path after moving the bills already transported into the holding areas upon suspension of the operation of the transport mechanism in response to user input.

25. The method of claim **16** further comprising the act of detecting the presence of a bill jam in one of the holding areas when a bill is not transported past one of the plurality of bill passage sensors disposed adjacent the holding area

within a requisite number of encoder counts, and wherein the act of moving the bills already transported into each of the holding areas further comprises the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein to the corresponding storage areas upon suspension of the operation of the transport mechanism.

26. The method of claim **25** further comprising the act of receiving input from a user of the device via a user interface, the input including operational instructions, and wherein the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein further comprises the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein to the corresponding storage areas upon suspension of the operation of the transport mechanism in response to user input.

27. The method of claim **26** wherein the act of flushing the bills further comprises the act of flushing the bills from the transport path after the act of moving the bills already transported into the holding areas upon suspension of the operation of the transport mechanism in response to user input.

28. The method of claim **16** wherein the act of determining information further comprises the act of determining information concerning the bills with an evaluating unit at a rate of at least about 800 bills per minute.

29. The method of claim **16** wherein the act of determining information further comprises the act of determining information concerning the bills with an evaluating unit at a rate of at least about 1500 bills per minute.

30. The method of claim **16** further comprising the acts of:

reversing the face orientation of a bill with a bill facing mechanism where the face orientation of a bill does not match a target orientation and;

detecting the presence of a bill jam in the bill facing mechanism when a bill is not transported past one of a plurality of bill passage sensors disposed along a transport path of the bill facing mechanism within a requisite number of encoder counts.

31. A method for processing currency bills with a currency handling device, the method comprising the device performing the acts of:

receiving a stack of a plurality of bills in an input receptacle;

transporting the bills with a transport mechanism, one at a time, from the input receptacle along a transport path into a plurality of output receptacles, at least one of the plurality of the output receptacles including a holding area and a corresponding storage area;

determining information concerning the bills with an evaluating unit;

maintaining a count of the total number of bills transported into the holding area;

moving the bills transported into the holding area into the corresponding storage area after a predetermined number of bills have been stacked in the holding area;

maintaining a count of the total number of bills moved into the storage area;

tracking the movement of each of the bills along the transport path with a plurality of bill passage sensors, each of the plurality of sensors being adapted to detect the passage of a bill as each bill is transported past each sensor;

generating an encoder count for each incremental movement of the transport mechanism; and

detecting the presence of a bill jam when a bill is not transported past one of the plurality of bill passage sensors along the transport path within a requisite number of encoder counts.

32. The method of claim **31** further comprising the act of suspending operation of the transport mechanism upon detection of a bill jam.

33. The method of claim **32** further comprising the act of moving the bills already transported into the holding area to the corresponding storage area upon suspension of the operation of the transport mechanism.

34. The method of claim **33** further comprising the act of updating the count of the number of bills moved into the storage area by adding thereto the count of the number of bills transported into the corresponding holding area prior to moving the bills from the holding area to the corresponding storage area upon suspension of the operation of the transport mechanism.

35. The method of claim **34** further comprising the act of resetting the count of the total number of bills transported into the holding area.

36. The method of claim **33** further comprising the act of receiving input from a user of the currency handling device via a user interface, the input including operational instructions, and wherein the act of moving the bills already transported into the holding area to the corresponding storage area further comprises the act of moving the bills already transported into the holding area to the corresponding storage area after suspension of the operation of the transport mechanism in response to user input.

37. The method of claim **33** further comprising the act of flushing the bills from the transport path after the act of moving the bills already transported into the holding area to the corresponding storage area.

38. The method of claim **37** further comprising the acts of receiving input from a user of the currency handling device via a user interface, the input including operational instructions, and wherein flushing the bills further comprises the act of flushing the bills in response to user input.

39. The method of claim **33** wherein a plurality of the plurality of output receptacles include a holding area and a corresponding storage area, the method further comprising the acts of detecting the presence of a bill jam in one of the holding areas when a bill is not transported past a predetermined position within the holding area within a predetermined amount of time, and wherein the act of moving the bills already transported into each of the other holding areas further comprises the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein to the corresponding storage areas upon suspension of the operation of the transport mechanism.

40. The method of claim **39** further comprising the act of receiving input from a user of the device via a user interface, the input including operational instructions, and wherein the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein further comprises the act of moving the bills already transported into each of the holding areas not having a bill jam detected therein to the corresponding storage areas upon suspension of the operation of the transport mechanism in response to user input.

41. The method of claim **40** further comprises the act of flushing the bills from the transport path after moving the bills already transported into the holding areas not having a bill jam detected therein upon suspension of the operation of the transport mechanism in response to user input.

42. The method of claim **40** wherein the act of determining information further comprises the act of determining information concerning the bills with an evaluating unit at a rate of at least about 800 bills per minute.

43. The method of claim **40** wherein the act of determining information further comprises the act of determining information concerning the bills with an evaluating unit at a rate of at least about 1500 bills per minute.

44. The method of claim **40** further comprising the acts of:

reversing the face orientation of a bill with a bill facing mechanism where the face orientation of a bill does not match a target orientation and;

detecting the presence of a bill jam in the bill facing mechanism when a bill is not transported past one of a plurality of bill passage sensors disposed along a transport path of the bill facing mechanism within a requisite number of encoder counts.

45. The method of claim **40** further comprising the act of stacking the bills in each of the holding areas.

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